POWER PLANT ENGINEERING

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Workings of the Engineering Dept. of the Fuel Administration

METHODS EMPLOYED IN THE STATE OF ILLINOIS FOR HANDLING QUESTIONNAIRES, CLASSIFYING POWER PLANTS AND DISTRIBUTING TECHNICAL ADVICE ON CONSERVATION OF FUEL

AMONG THE FIRST PROMINENT engineers of the country to advocate publicly the government control of power plants as an aid to the conservation of coal was Joseph Harrington, who is now Administrative Engineer for the state of Illinois. It is natural, therefore, to look for original ideas in the methods he has adopted for conducting the affairs of the office. His policies are summarized as follows:

a. Advise owners and operators the part of the plant where losses are occuring.

b. Instruct them *how* such losses may be stopped.

c. Require from such owners or operators weekly reports of improvements made.

All power plants of the state have received the standard questionnaire, published on pages 566 and 567 of the July 15, '18, issue, covering the operation of steam power plants, as well as all other Government literature making suggestions to power plants for increasing their economy in the use of fuel.

To grade the answers to the questionnaires and give the plants their ratings, volunteers were called for among the engineers of the state, who donate as much

JOSEPH HARRINGTON, ADMINISTRATIVE ENGINEER FOR THE STATE OF ILLINOIS

of their time as possible to this work. As might be expected, responsible engineers in all branches of power plant work have responded to the call and are grading as rapidly as possible all questionnaires that have been received.

Likewise a call was sent out for volunteer inspectors, who spend one or two days a week visiting power plants to check up the answers in their questionnaires and make suggestions where improvements can be made to bring up their rating, which, of course, means improved efficiency.

In Fig. 2 is reproduced the form letter sent to power plants whose questionnaires have been examined and graded.

The Administration does not stop here, however; it expects the plant to increase its per cent rating, particularly if below 80 per cent.

To keep a check on the plants, an ingenious chart has been devised by means of which the condition of a plant and its improvements are visualized. This chart, shown in Fig. 3, has a line plotted upon it, the values represented being taken from the results of the questionnaire. For example, each principal question, A to H, is allowed a certain number of points if conditions are considered correct, as indicated in the column to the right in the chart. If the answer is not satisfactory, a certain amount is deducted from this figure, according to the degree of imperfection. The line is drawn from the upper corner; each division from the vertical line marked O represents one point, and vertical divisions are so proportioned for each question that when correct conditions exist that section of the line will have a slope of 45 deg. from the horizontal, i.e., parallel to the diagonal boundary line. Improvements in the plant will change the slope of the line so that the 100 per cent plant will have a line coinciding with the straight diagonal border line.

For each plant a separate card is kept, and reported improvements are plotted so that inspectors can readily check up the co-operation the Administration is receiving from the power plant management. To illustrate how this chart is used, three lines have been drawn to represent the results of three inspections, A, B and C, approximately one month apart. When the plant has reached its maximum obtainable the upper left-hand corner is clipped off.

It is now planned to send a weekly news letter, prepared by Mr. Harrington, to each power plant under his jurisdiction, in which will be discussed one particular item of fuel economy. These letters will be followed up by inspectors sent to the power plants where the particular information should be of value in raising the rating of the plant. The inspectors will thus keep in touch with plants of low rating, which will be given all advice possible from the administration, in return for which greatly improved conditions will be expected.

To aid in the distribution of these news letters and to take care of all conservation work in the manufacturing districts of the state, manufacturers' associations are being organized in the various large cities. These associations will stand the expense of mimeographing and distributing conservation literature and will keep track of improvements along the lines directed by the Administration.

What the Administration desires in every plant is that it be fully equipped with machinery and instruments that will enable the operators to secure the highest possible efficiency; then the men in charge of operation are expected to produce results suitable to the plant equipment. The following brief analysis of the items upon which the rating is based may prove of value to some in bringing up their rating.

Fuel must be used to advantage; that is, the furnace and boiler must be so proportioned to the load that an economical rate of combustion can be maintained, say, between 20 and 30 lb. of coal per square foot of grate surface per hour. There must also be a record kept of

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UNITED STATES FUEL ADMINISTRATION

RAYMOND E. DURHAM
FEDERAL FUEL ADMINISTRATOR FOR ILLINOIS

308 SOUTH WABASH AVENUE
CHICAGO

IN REPLYING, PLEASE ADDRESS BOTH LETTER AND ENVELOPE TO DEPARTMENT FROM WHICH THIS LETTER IS RECEIVED

TELEPHONE WABASH 7767

ORGANIZATION
C. O. FOWLER, Director of Dealer Distribution
T. D. PAYNE, Director of Industrial Distribution
CHARLES A. LIND, Public Utilities and Institutions
F. N. PEASE, Anthracite Distribution
L. E. HART, Director of Enforcement
J. W. ADAMS, Director of Prices
HAROLD ALMERT, Director of Conservation
JOSEPH HARRINGTON, Administrative Engineer
NELSON G. PHELPS, Engineer, Oil Division
JAMES ANDERSEN, Statistician

The answers on the "Standard Questionnaire Covering the Operation of Steam Power Plants" for your Plant at received and have been carefully examined and rated as follows;

ITEMS	Maximum Mark Obtainable	Mark Received
(a) Fuel	- 9 -	3
(b) Water	- 15 -	2
(c) Air Supply	- 12 -	4
(d) Clean Heating Surface	- 12 -	7
(e) Boiler & Furnace Settings	- 20 -	10
(f) Insulation	- 7 -	3
(g) Engine Room & Heating Surfaces	- 15 -	12
(h) Supervision	-.10 -	4
TOTAL	- 100% -	45

This mark on the basis of 100% standard, indicates how well you are using your present equipment for the conservation of fuel.

If you will report any further substantial improvements in equipment or operation from time to time we will cheerfully reinspect and reclassify your plant.

Very respectfully yours,

ADMINISTRATIVE ENGINEER.

FIG. 2. PARTIALLY FILLED-OUT FORM LETTER SENT TO POWER PLANT OWNERS AFTER FIRST CLASSIFICATION HAS BEEN MADE

the fuel used, a record that will enable a man to detect inefficiencies as they occur and not allow them to exist for a week or month before they are discovered. A daily record is, therefore, recommended in all plants and the fuel consumption should be compared regularly with the load output.

Feed water should be heated with exhaust steam where such is available and in some of the larger plants a waste heat economizer is considered a necessary equipment. It is also expected that the feed water be measured continuously so that a close estimate of the evaporation per pound of fuel can be made daily.

and exhaust lines where fuel can be conserved by covering.

Considerable credit is given to the plants where efficient use is made of all exhaust steam and it is expected that no exhaust steam will go to waste when it can be utilized to save fuel in any way.

Supervision plays an important part in the operation of a power plant and a fair estimate of the character of the supervision can be had from answers to the questionnaire, for they show whether the plant is up to date in equipment, whether the routine operation is up to standard and what improvements are contemplated.

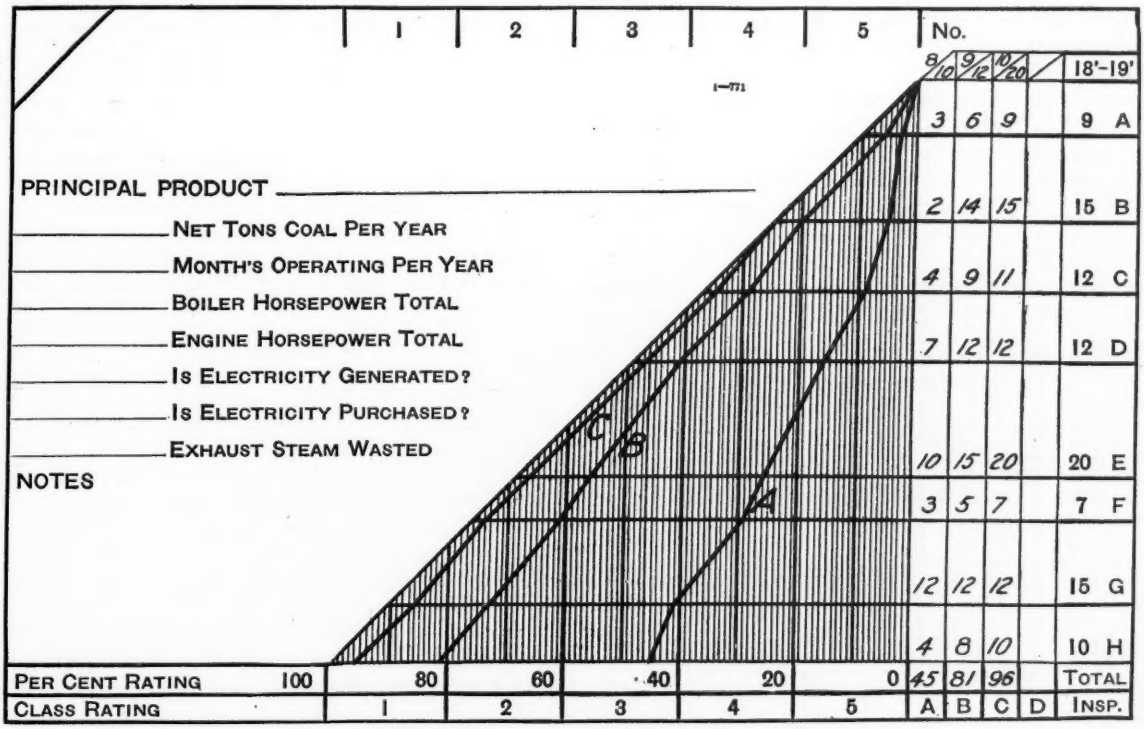


FIG. 3. CHART FOR VISUALIZING PLANT IMPROVEMENTS AND RECLASSIFICATION

Control of the air supply is extremely important; for this purpose an automatic damper should be provided in the main stack and in the uptake of each boiler a damper with accessible hand control is advisable. To determine that combustion is right a gas analysis instrument is necessary and draft gages are important for maintaining correct draft conditions.

Clean heating surfaces are necessary for efficient operation and credit is given the plant if it is provided with means for keeping these surfaces in good condition; the more efficient the means and the more frequently they are used the higher the credit. Under this head also comes the treatment of feed water.

Great importance is placed upon the condition of the boiler and furnace settings as it will be noted one-fifth of the plant rating depends upon these conditions. Baffles and bridgewalls must be in first class condition and all air leaks in the setting should be stopped.

Heat wasted by radiation is another important item and should be reduced by insulating all exposed parts of boilers, steam piping, feed-water heaters, feed lines

Although no summary is as yet possible it would appear that the principal cause of failure to meet the Administration's requirements is the lack of proper authoritative supervision which results in inadequate equipment for keeping heating surfaces clean, maintaining proper draft conditions and keeping a comprehensive record of operation.

The Administrative Engineer for Illinois is a high authority upon the use of fuels; he has surrounded himself with a corps of workers who are extremely desirous of bringing power plants up to the highest pitch of economy, and no power plant should fail to co-operate with this organization, which is endeavoring by every means possible to increase its fuel economy.

THE FIRST STEEL ship built without rivets has just been launched on the south coast of England. The plates were fused together by electric welding in one process. General adoption of this process, it is held, would effect a saving of from 20 to 25 per cent.

Increasing Engine Economy---IV

Effects on Capacity and Efficiency of Running Engine Condensing. By M. A. Saller

If a steam engine is being properly operated, i.e., if the valve setting, steam supply, and lubrication are all satisfactory, and it is desired to secure more power or better economy, then one of the three following alternatives is left:

(1) Run the engine condensing,

(2) Add a low-pressure cylinder, making a compound engine, usually also run condensing,

(3) Add a low-pressure turbine and condenser.

The advantage to be gained from running condensing lies in the fact that the condenser removes the back pressure from the exhaust, and establishes a vacuum in its place, the effect on the diagram being the addition of the portion shaded on the illustration attached.

Assuming that a vacuum of 26 in. of mercury is insured by the condenser, it can be figured that the mean effective pressure of the engine will be increased by about 12 lb. per sq. in., assuming that the cutoff is maintained as originally. Since this gain in pressure lasts throughout the stroke, it can be added directly as an increase in the mean effective pressure. This increase, as stated above, will ordinarily average 12 lb. so that the gain in power bears the same relation to the power previously developed as 12 does to the former mean effective pressure. Take, for example, a 200-hp. engine running noncondensing with 5 per cent clearance, ¼ cutoff, 100 lb. steam pressure and 2 lb. back pressure. Using the mean pressure ratio of 0.62, as given in Table I for given cutoffs and clearance percentages, the mean effective pressure would be 115×0.62—17 lb. absolute back pressure, or 54 lb. An increase of 12 lb. in the mean effective pressure following the addition of a condenser would result in a gain of 22.2 per cent when running with the same cutoff.

TABLE I. MEAN FORWARD PRESSURE PER POUND ABSOLUTE INITIAL PRESSURE

Cutoff.	Per Cent. Clearance. 0	1.75	3	5	7	9
1–10	0.330	0.354	0.369	0.392	0.413	0.432
1–8	0.384	0.405	0.418	0.438	0.457	0.474
1–6	0.465	0.481	0.492	0.509	0.524	0.538
1–5	0.522	0.535	0.545	0.559	0.572	0.584
1–4	0.597	0.607	0.615	0.626	0.636	0.646
5–16	0.676	0.684	0.689	0.698	0.706	0.713
1–3	0.699	0.707	0.713	0.719	0.727	0.734
3–8	0.742	0.749	0.753	0.759	0.765	0.771
2–5	0.766	0.771	0.775	0.781	0.786	0.792
7–16	0.799	0.804	0.807	0.812	0.819	0.820
1–2	0.846	0.850	0.852	0.856	0.858	0.862
5–8	0.919	0.920	0.921	0.923	0.925	0.926
3–4	0.966	0.966	0.966	0.967	0.968	0.969
4–5	0.978	0.978	0.979	0.979	0.980	0.981
9–10	0.995	0.995	0.995	0.995	0.995	0.995

When changing over to condensing operation, however, when the same load is carried, a shorter cutoff is used than when running noncondensing. Figure 2 shows a typical card before and after changing to condensing after the cutoff has been changed from ¼ to 1/6. While the areas of the diagrams and the work done are identical, the cutoff occurs earlier, hence a smaller quantity of steam is used. If in place of the ¼ cutoff, the 1/6 cutoff will give the same power when running condensing, the saving in steam will be the difference between the volume of steam required at ¼ and at 1/6, or 33 per cent. Therefore running condensing under the conditions stated will either add 22 per cent to the power developed, or reduce the steam consumption by about 33 per cent.

Table II shows the effect of running condensing as compared with noncondensing operation, taking into account the factors affecting the various types of engines.

Against this saving, however, must be charged the cost of the extra condensing equipment, the added maintenance, etc., all of which are affected by factors such as the nature and quantity of cooling water, available head-room, etc. Running the engine condensing also precludes the use of the exhaust steam for heating or drying purposes, hence where exhaust steam can be utilized for heating the feed water or industrial water, or for heating buildings, kilns, etc., it does not pay to install a condenser because the gain in economy in the engine is counterbalanced by the added cost of generating additional live steam to take care of the heating load.

TABLE II. PERCENTAGE GAINED BY RUNNING ENGINE CONDENSING

Type of Engine. Name.	Feed-water per Indicated Horse-power per hour. Non-Condensing. Probable Limits.	Non-Condensing. Assumed for Comparison.	Condensing. Probable Limits	Condensing. Assumed for Comparison.	Per Cent. Gained by Condensing.
	lb.	lb.	lb.	lb.	
Simple High-speed	35 to 26	33	25 to 19	22	33
Simple Low-speed	32 to 24	20	24 to 18	20	31
Compound High-speed	30 to 22	26	24 to 16	20	23
Compound Low-speed	—	24	20 to 12¾	18	25
Triple High-speed	27 to 21	24	23 to 14	17	29
Triple Low-speed	—	—	18 to 12¾	16	—

As showing the comparison between the initial cost of various types of condensers, using different temperature cooling water, the curves (Fig. 3) established by A. E. Scanes, an English engineer, will be of interest, though the money values indicated thereon will not apply under the present-day high material costs; however, the comparative cost between the various types is still doubtless maintained. The same engineer has also graphically indicated the comparison of the running costs of the three general types of condensers, as the curves show.

The simplest form of condenser to use is the jet condenser, because this can be purchased at less cost than the surface condenser, takes up less space and can often be installed to operate without the use of extra pumps; however, with the jet condenser the exhaust steam is mixed direct with the cooling water and is carried away with it. Where it is desired to conserve the condensed steam, the surface condenser can be used to best advantage. Where the boiler feed water is of poor quality, the latter point is of great importance

because the use of the pure condensate for boiler feeding often makes it unnecessary to install complete softening equipments for treating the raw water supply.

In the single-cylinder engine, if increased economy is sought for by resorting to a high ratio of expansion, it will be found that a considerable portion of the added economy may be offset by excessive cylinder condensation due to the cooling of the cylinder walls during the exhaust at low temperature. However, if the expansion is distributed between two or more cylinders, the temperature range in each stage can be reduced, and with it the loss due to cylinder condensation. As giving some

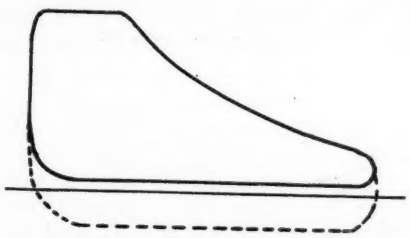


FIG. 1. EFFECT ON INDICATOR DIAGRAM OF ADDING CONDENSER, CUTOFF REMAINING THE SAME

idea of the temperature range encountered in the engine cylinder, take a 300-hp. simple engine running at 175 lb. pressure. The temperature of the incoming steam would be about 385 deg., and expanding it to 1 lb. absolute, or a temperature of 102 deg. involves a temperature drop of 283 deg., and because of the quick cooling of the cylinder walls, the incoming steam at 385 deg. at each stroke would be condensed when it encountered the cylinder wall, which is comparatively cooler, i. e., about 100 deg. When the engine is compounded, in the high pressure cylinder the steam would be expanded down to 27 or 28 lb. absolute, or a temperature of 245 deg., the temperature difference amounting to only 142 deg., or about half the drop encountered in the simple engine.

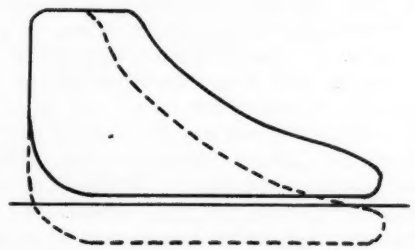


FIG. 2. COMPARISON OF INDICATOR DIAGRAMS FROM ENGINE RUNNING NONCONDENSING AND CONDENSING CARRYING THE SAME LOAD

Therefore where high pressure steam is available, it is the best policy to make use of a compound engine to secure the best possible advantage of the expansive effect of the steam with the minimum loss from cylinder condensation.

Where compound cylinders are used it should also be remembered that some of the steam condensed in the high pressure cylinder is re-evaporated during exhaust and enters the low-pressure cylinder as steam, still further cutting down the loss from cylinder condensation. With the compound engine, also, the load on the crank shaft can be more evenly distributed, hence reducing friction loss.

The compound engine is mainly desirable because of the increased capacity and economy which can be obtained by increasing the expansion ratio of the steam, and hence the useful work secured from it. For this reason it is hardly ever advisable to convert a simple engine into a compound engine where the boiler pressure is not over 90 or 100 lb. If the pressure is below these points, then the addition of a condenser alone, without the low-pressure cylinder, as outlined above, would be the best procedure.

When a compound cylinder is added it is very essential for successful operation that the proper ratio between the two cylinder areas be established, so that the work may be evenly distributed. Ordinarily for steam pressures ranging from 125 lb. to 200 lb., and if the engine is running noncondensing, the cylinder ratio that will probably be found best will be 2½ or 3 to 1. For condensing units, running on a steady load, and at

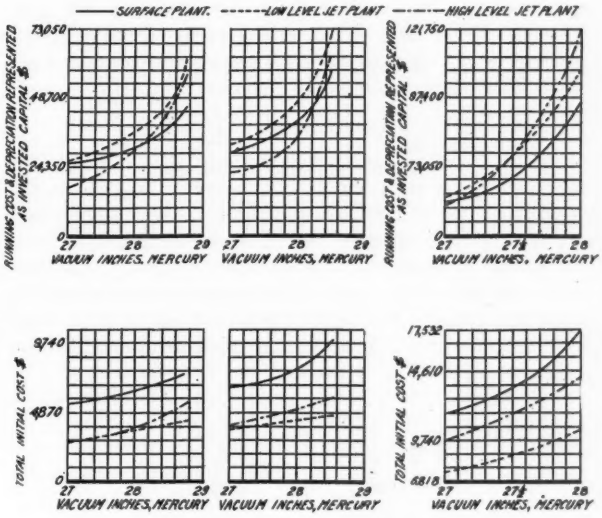

SURFACE PLANT.
LOW LEVEL JET PLANT
HIGH LEVEL JET PLANT
RUNNING COST & DEPRECIATION REPRESENTED AS INVESTED CAPITAL $
TOTAL INITIAL COST $
VACUUM INCHES, MERCURY

FIG. 3. COMPARISON OF RUNNING AND INITIAL COSTS OF VARIOUS TYPES OF CONDENSERS

pressures between 125 and 150 lb., the most economical results will be found with a ratio of 4 or 5 to 1.

Where the simple engine is already in service, the addition of a low-pressure cylinder in cross compound arrangement involves the determination of the proper size cylinder to use based on the general proportions given above, following which the foundation should be so built that the center line of the low-pressure cylinder is parallel to that of the high-pressure cylinder, so that the low-pressure cylinder can be arranged to drive the same shaft as is being operated by the high-pressure cylinder. Further than the provision of the cylinder and its proper foundations, it is necessary to extend or make a new double crank shaft with the cranks placed at 90 deg., and then pipe the exhaust steam from the high-pressure steam to the low-pressure cylinder, possibly introducing in this line a receiver for storing up the exhaust and evening out the flow. In this receiver are sometimes placed heating coils for re-evaporating any

water of condensation which may have collected. As pointed out in the early part of the article, it is also desirable to reset the valves on the high-pressure cylinder so that an earlier cutoff may be secured.

As an example of what can be saved by compounding an engine, take a simple engine with 20-in. diameter piston with 42-in. stroke, operating at 90 r.p.m., and at 95 to 100 lb. pressure. With an average cutoff of 1/3, or at 14 in. on the stroke, the mean effective pressure would be about 59 lb., and the engine would develop about 350 hp. After the addition of a low-pressure cylinder, the cutoff in the primary cylinder could be reduced to less than 1/3, or about 12 in. on the stroke, so that the mean effective pressure would be about 38 lb., at which pressure that particular cylinder would develop about 225 hp. Using a cylinder ratio of 2 to 1, the power developed in the second cylinder would be about 125 hp., making a total of 350 hp. In securing this same capacity from the compound engine, however, less steam was used than in the simple engine because in the latter 1/3 cutoff was used, whereas in the former instead of a rate of expansion of 3, the ratio of expansion would be approximately 7. In both cases the same power is developed, but in one case the cutoff is at 14 in. and in the other at 12 in., a saving of 2 in. on 14 in., or 1/7, or approximately 15 per cent.

Using Low-Pressure Turbines

Another comparatively modern development for increasing the capacity and economy of engine plants is that of the low-pressure turbine, using the exhaust from reciprocating engines. The engine operates most economically down to atmospheric pressure. The turbine, on the other hand, is extremely economical for operation from atmospheric pressure down to a high vacuum, the gain from running condensing in the case

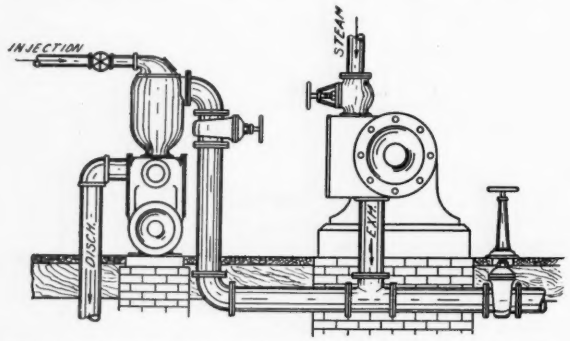


FIG. 4. METHOD OF PIPING A SIMPLE ENGINE TO A JET CONDENSER

of the turbine being from 80 to 90 per cent. Consequently the combination of an engine using high-pressure steam and exhausting it through a low-pressure turbine to the condenser represents almost an ideal combination, and one that is quite practical because of the ease and facility with which the turbine and condenser can be added to any ordinary engine installation. Practice has shown that a low-pressure turbine of, say, 300 hp. capacity will develop a horsepower on about 28 lb. of steam expanded from atmospheric pressure into a 28-in. vacuum, or, in other words, secure the same power from the exhaust steam as the simple engine would from the high-pressure steam, and therefore increasing the capacity 100 per cent without using more steam or burning more fuel other than is represented by that required to operate the condenser auxiliaries, which in a properly designed and operated plant should not run more than 3 per cent of the power generated by the engine or turbine. In some plants where a large quantity of condensing water must be handled, or where the head is high, or where the cooling water is dirty and hence causes clogged turbines, etc., the cost of operating the condenser and auxiliaries will run as high as 12 per cent, but ordinarily it will average between 2 and 6 per cent.

As a typical example of what can be done with a low-pressure turbine, the case of a planing mill can be

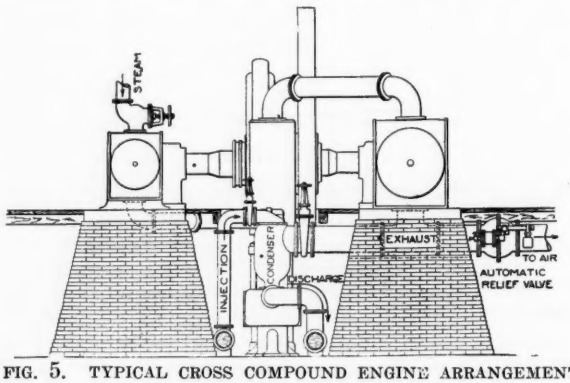


FIG. 5. TYPICAL CROSS COMPOUND ENGINE ARRANGEMENT

cited. One hundred and fifty-kw. load was being carried on the present engine and boiler, and additional power to run motors, etc., was purchased from the street to the extent of about $250 a month, and this because it was impossible to find space to install additional boiler capacity. A 100-kw. low-pressure turbine, with jet condenser and water circulating pump, with necessary piping and relief valves, was purchased and installed in the present engine room at a cost of about $10,000. The 100 kw. produced by the low-pressure turbine in addition to the power ordinarily generated by the engine eliminated the necessity for purchasing outside current and thus effected a saving of about $2500 a year. Based on the initial investment of $10,000, this installation will pay for itself in a little over 4 yr. time, and further makes the plant independent of outside assistance for power. What slight extra fuel was burned to operate the extra auxiliaries was not a factor because wood refuse was present in excess quantities, and represented no extra cost other than a slight handling charge.

Where the exhaust steam from the engine to the turbine is constant and does not fluctuate widely, the exhaust can be piped direct to the turbine, possibly installing in the line a separator for removing the oil and water, or a large receiver for this same purpose or for storing up the steam to provide a reserve on which the turbine can draw. In the case of rolling mill or hoisting engines where the exhaust is intermittent, however, it is necessary to provide some means for supplying the turbine with steam in the intervals between the engine exhausts. This can be done in one way by having a supplementary live steam supply line to the tur-

bine which will admit live steam to keep the turbine up to speed at such times when the exhaust steam is insufficient; however, in this case extra live steam is used, and the exhaust steam when it does come is not fully utilized because of the limited capacity of the turbine. In some plants, therefore, regenerators are provided for storing up the excess exhaust steam so that when the exhaust supply runs low the turbine can draw on the regenerator for exhaust steam until the exhaust again exhausts, thus eliminating the use of live steam and utilizing all the exhaust. The generator is arranged to store up automatically the heat contained in the exhaust steam in a body of water, the generator being arranged so that the incoming steam is discharged below the water line through perforations in such a way as to set up rapid water circulation. The engine exhaust is usually entered at about atmospheric pressure and is exhausted into the turbine at a vacuum. When the regenerator has an excess of steam, the temperature and pressure in the regenerator rise and the whole body of water is heated up, and having no method of escape, is retained. Then when the exhaust falls off, the turbine, pulling a vacuum, reduces the pressure in the regenerator, and, because of the reduced pressure, heat is given up by the water in the form of steam. The

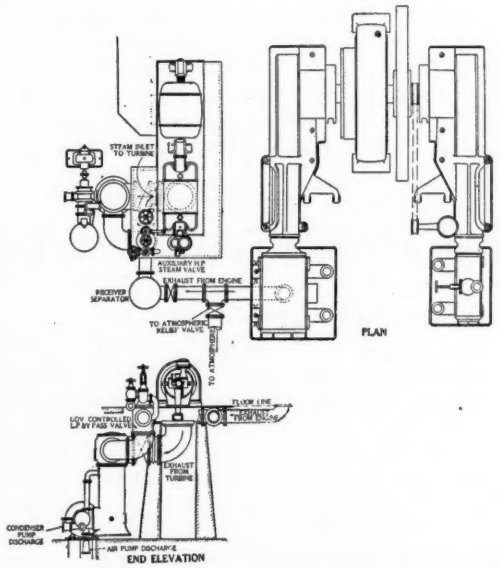


FIG. 6. ARRANGEMENT OF COMPOUND ENGINE AND LOW-PRESSURE TURBINE

holding capacity of the regenerator is, of course, based on the quantity of water it holds and the pressures carried. In some regenerators provision is made for the admission of live steam in case the supply of exhaust falls off for a period longer than the regenerator is able to supply the steam. Usually the regenerator can maintain the turbine in operation for a period of 3 to 5 min. at full load, or about 6 to 8 min. at reduced load.

In some respects the exhaust steam heating system bears the same relation to the economy of an engine as a condenser, though, of course, not in such a marked degree. Frequently it will be found that it is necessary to carry back pressure on the engine in order to force the exhaust steam through the heating coils, but more frequently it will be found that the back pressure carried is far more than is actually required. Often ¾ lb. or 1 lb. back pressure will be ample to force the steam through the system, and yet the back pressure valve is weighted down to carry a back pressure of 3, 4 or 5 lb. pressure, and usually because the engineer does not pay any particular attention to finding out just what pressure will suffice. The back pressure valve is usually set at the beginning of the heating season and remains at the same point throughout the season, irrespective of changes in weather or changes in the exhaust steam requirements. Operating an engine under an excess back pressure of 4 or 5 lb. per sq. in. will increase the steam consumption of the engine by some 10 per cent, so that

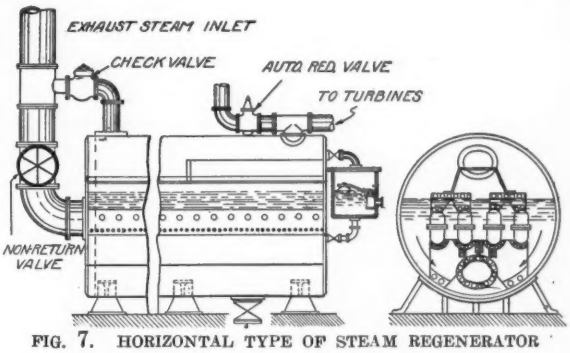


FIG. 7. HORIZONTAL TYPE OF STEAM REGENERATOR

the importance of this item should not be overlooked. Frequently even the slight amount of back pressure required to force the exhaust through the heating system can be eliminated by placing on the outlet of the heating system a vacuum pump for removing the water of condensation and pulling a slight vacuum on the system which will draw the steam through the system by vacuum instead of imposing back pressure on the engine to accomplish the work. By removing such back pressure the use of the vacuum system of heating will often effect a clear saving in engine economy of 5 to 10 per cent.

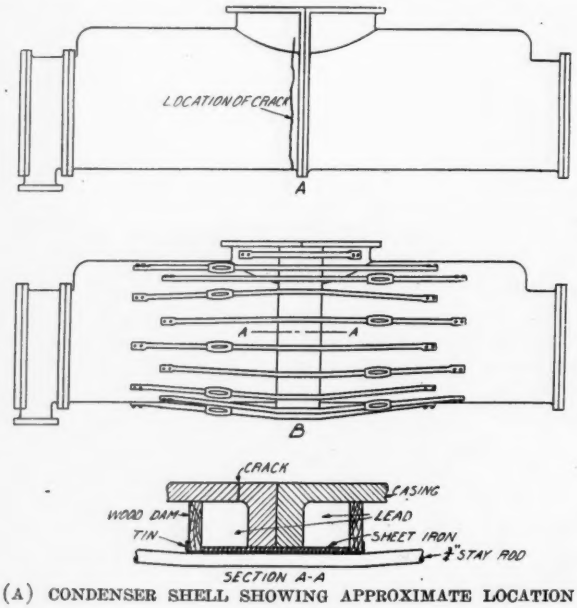
In exhaust piping to condensers an appreciable loss can often be incurred by permitting leakage of air. The pipe being under a vacuum readily sucks in air, impairing the vacuum, imposing extra work on the vacuum pumps and logging the condenser with air pockets. Leaky atmospheric relief valves admitting air into the condenser are also common occurrences.

SUGGESTION is made by the National Americanization Committee that in order to conserve paper, large envelopes which are usually used unsealed, are now expensive and hard to get, may be reused by having printed large labels which will cover the old address. They may be gotten from any printer, or the committee will supply them at cost plus postage, $3 a thousand, in a size 6 by 8½ in. This covers the old address and return address and makes the used envelope as good as new. If you are in doubt as to whether it will pay, try saving the incoming large envelopes for a week and see what they would cost to buy new. A legend on the label, "When you save paper you save coal. Coal is essential to win the war"; and another, "When you save a little, buy W. S. S.," give force to the use of the relabeled envelopes.

A Novel Condenser Repair

IN the design and construction of the piping systems of steam power plants, care must be observed in providing means to compensate for the alternate expansion and contraction to which such systems are ordinarily subjected. Neglect to do so is eventually bound to result in serious trouble, such as recently occurred in a Wisconsin central light and power station.

Essentially, the prime mover equipment of this plant consists of two 400-kv.a. and one 2500-kv.a turbo-alternators, each provided with its individual condenser and auxiliaries, but so arranged and interconnected as to allow the smaller units to exhaust into the condenser of the 2500-kv.a. set which is of the surface type with 4000 sq. ft. of condensing surface and fitted with its individual circulating, condensate and air pump located in a pit directly below. The designers of this installation,



(A) CONDENSER SHELL SHOWING APPROXIMATE LOCATION OF CRACK

(B) GENERAL APPEARANCE OF CONDENSER AFTER REPAIRS HAD BEEN MADE

through neglect, oversight or otherwise, failed to provide for expansion and contraction of the common exhaust line between the small units and the large condenser. As a consequence, enormous strains must have been set up within this line as would appear from results, the throwing out of alinement of the pumps and the cracking of the condenser shell at the point indicated in the accompanying illustration.

Attempts were made to secure a new condenser, but due to a present government ruling regarding the use of new condensers only for naval or merchant marine purposes, no manufacturers were able to fill the order without a certificate of priority. This, however, was not obtainable, thus making it necessary to devise ways and means whereby the damaged shell might be repaired.

All steam and water lines which in any way tended to contribute to the strains placed upon the condenser were removed. A sheet iron band having a thickness of about ¼ in. and 10 in. wide was secured and placed around the greater part of the shell, the vertical center flange serving as a separator between this band and the outside wall of the condenser. Over the band and with sides turned inward to form a backing for a wooden dam carried around the girth of the shell was placed a covering of tin which, together with the iron band and the various sections of the dam, was held in place by ¾-in. stay rods. Each of these was provided with an adjustable turn buckle and was secured to the shell by short machine bolts for which holes were drilled and tapped.

The construction of these rods and the method employed to secure them to the shell is as shown in the accompanying illustration, and in order not only to avoid weakening the castings due to the drilling of the holding bolt holes, but also to facilitate adjustment, these rods were staggered.

After all was in readiness the space between the outer wall of the shell and the iron band was filled with about 900 lb. of molten lead, the wooden dam referred to above serving to retain the lead while still in the liquid state. With the entire space filled in such a manner as to provide a belt of lead over the crack and about the greater portion of the girth of the shell, the tin covering was cut away, the dams removed and the tension on the stay bolts taken up to secure the lead properly and provide an air-tight joint.

At present no information is available as to the performance of this condensing unit, but with the insertion of the necessary expansion joints in the connecting pipe lines, and the re-alinement of the condenser pumps, it is probable no further trouble will be experienced, at least not until it is possible to obtain a new condenser.

Burning a Million Tons of Coal a Year*

By Frank W. Casler†

THE SUPERVISING of the burning of a million tons of coal a year is indeed no small problem, especially in these times when we are obliged to take fuel that is unsuited to the furnace conditions of the various plants, some of these stations being equipped with mechanical stokers of various types and designs, and others with the ordinary grate and hand firing.

The method of procuring a coal supply today has materially changed from what it was in pre-war times; in other words, the pooling of coal gives us practically one grade for all plants and we are no longer able to select low volatile coals that are so necessary in hand fired plants, in order to eliminate the smoke nuisance.

Previous to war times our contracts called for coal to be delivered to hand fired plants, where the smoke abatement was an important factor, of not more than 17 or 18 per cent volatile matter; but now the average volatile in the coal for all of our plants ranges from 23 to 25 per cent, which adds materially to our difficulties in trying to cope with the smoke prevention problem.

Our method of purchasing coal is very simple; the contracts specify the average ash contained for any one month shall not exceed a certain percentage. Sufficient

*Abstract of paper read at the Annual Convention of the Smoke Prevention Association.

†General Superintendent of Production, Public Service Corporation of New Jersey.

leeway is allowed for reasonable variation, and should it exceed this amount penalties are applied, but no premiums are paid if the average falls below what is specified in the contract, the object being to maintain as nearly as possible a uniform supply of fuel. Our method of arriving at the quality of coal is this:

A sample of about 1000 lb. of coal is assimilated from every 500 tons as it is received, from which small samples are prepared in the usual way of grinding, quartering, etc., and are properly marked and sent to the laboratory for analyses.

These analyses are averaged up at the end of each month and if the ash content has not exceeded that specified, we consider that the standard quality of coal has been furnished.

Previous to war times, a number of penalties were applied and considerable money was refunded. These refunds showing up in our power costs as they did, proved our methods of purchasing coal were reasonably correct. All of our 16 principal plants, generating approximately 90 per cent of our total power, are equipped with water meters, which periodically give us an evaporative test of each day's performance in the boiler room.

Further, frequent tests are made of our engines and turbine units to see that the amount of steam generated is being used efficiently, and each engineer operating one of our plants has prompt knowledge of the quality of coal he is getting and the over-all efficiency that should be obtained, and is in a position to detect waste very promptly, and correct this waste so that our plants are always maintained at their maximum.

Coal-Saving Suggestions

JUST at this time, when the conservation of coal is an absolute necessity and every practical suggestion for such conservation is a shot at our enemy, everybody realizes that smoke issuing from boiler stacks represents unused heat units, but not everybody realizes that certain simple rules, if observed in the fire room, will materially decrease this loss. The suggestions herein are based on many years' experience of the Westinghouse Electric & Mfg. Co.'s combustion engineers and are briefly outlined below.

1. Give your firemen an opportunity to acquire the fundamental principles of fuel burning.

2. If you have a difficult fuel problem, consult a combustion engineer.

3. Prevent smoke by proper firing methods.

4. Use gages to indicate exactly the condition of fire bed at all times. As a minimum, these gages should consist of draft gage indicating draft in furnace above fuel bed, draft gage indicating draft at boiler side of flue damper and a steam flow meter for individual boilers.

5. CO_2 is the principal product of complete combustion of coal; 10 to 12 per cent CO_2 should be obtained in flue gases to insure minimum fuel loss.

6. Avoid loss due to unburned coal in the ash.

7. If you are wasting exhaust steam you are wasting coal.

8. Do not permit grates to clog. A systematic method of keeping the air spaces clean must be followed.

9. Inspect the baffles in boilers, as broken or leaky baffles raise the flue gas temperature and waste coal.

10. Avoid leaking in of cold air around boiler setting.

11. Install stokers. Hand firing is rapidly being recognized as an obsolete and wasteful method of firing.

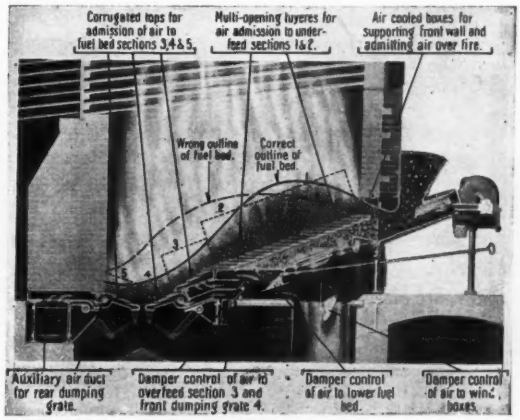
12. Clean scale from tubes, as every particle of scale represents wasted coal.

13. Avoid soot formation. All boiler tubes should be blown externally once every eight hours, when in continuous service.

14. All smoke flues should be as short and straight as possible. Flues should also be made air tight and all joints and connections should be well fitted, calked and riveted. Use asbestos gaskets on clean-out doors.

15. Locate flue dampers in front of boiler so that fireman will adjust them as required. Dampers located in rear of boilers are seldom disturbed regardless of conditions.

16. The size of coal has much to do with capacity and efficiency of boilers. In general, the air pressure penetrates the fuel bed formed by coarse coal more easily than that formed by finer coal, resulting in disturbance of best furnace conditions.


Corrugated tops for admission of air to fuel bed sections 3,4&5.
Multi-opening tuyeres for air admission to underfeed sections 1&2.
Air cooled boxes for supporting front wall and admitting air over fire.
Wrong outline of fuel bed.
Correct outline of fuel bed.
Auxiliary air duct for rear dumping grate.
Damper control of air to overfeed section 3 and front dumping grate 4.
Damper control of air to lower fuel bed.
Damper control of air to wind boxes.

TYPICAL FIRE BED FOR UNDERFEED STOKER

In addition to the foregoing suggestions, the following "don't fail to do" list should be followed.

Don't fail to:

Keep the heating surfaces of the boilers free from soot, scale or oil.

Keep the fires level and free from holes.

Do not carry the fires so thin as to draw a lot of excess air through.

Do not carry the fires so thick as to have incomplete combustion of the coal.

Do not soak the coal with water before firing.

Be sure the blowoff valves do not leak.

Do not have the safety valve popping off continually.

Cover steam pipes.

Do not waste steam through leaky valves or traps.

Never use live steam if exhaust steam is available and can be used as well.

An observance of the foregoing simple rules and suggestions should materially reduce the coal consumption of the average plant.

Efficiency of Preheated Air

Advantages and Systems of Introducing Preheated Air to Furnaces

PREHEATING air for use in boiler furnaces is not new in theory nor practice, its advantages in securing quicker combustion and higher furnace temperatures are easily understood and appreciated by anybody familiar with furnace operation. Nevertheless, the practice of preheating air for use in the furnace is the exception rather than the rule in power plants. It is recognized that little or no better economy is obtained when the air is heated in a separate furnace especially for this purpose and the difficulty has been to provide means for utilizing waste heat for this purpose.

Some idea can be gained as to the economy of preheating air by waste heat from the following: Suppose that the air supply is all heated 400 deg. F. above atmospheric temperature and that the furnace temperature is ordinarily 2500 deg. F.

The preheating of air will raise the temperature to 2900 deg. F. nearly.

If the air has derived its heat from a waste source as from the chimney, the economy will be as 29 to 25, or about 16 per cent.

This of course presumes a somewhat high temperature of the waste gases as well as an excessive weight of

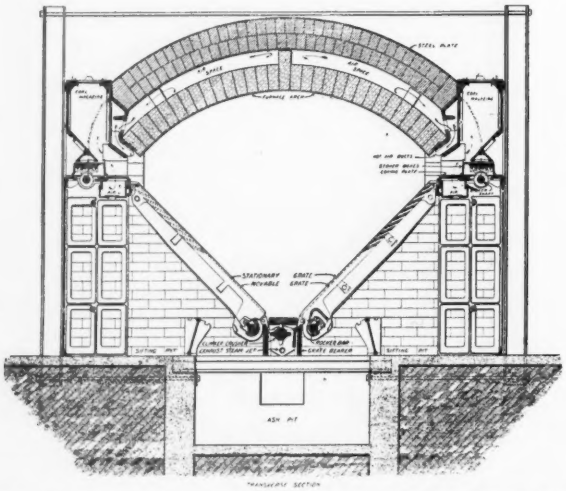


FIG. 1. MURPHY FURNACE SHOWING ARRANGEMENT FOR INTRODUCING PREHEATED AIR INTO FURNACE

air per pound of fuel, or the furnace temperature would be higher.

As a second example assume better conditions or a furnace temperature of 3000 deg. F. and air heated 300 deg. F. then the furnace temperature will become 3300 deg. F. and the economy is 10 per cent.

In addition to the calculated economy there would be the generally better combustion and the reduction of smoke due to better temperature. The efficiency of heat transmission to the water through the boiler plates would be improved by the greater head of temperature.

In the Murphy furnace, Fig. 1, we find a triple arch built over the entire furnace. Above the fire brick arch is an air space from 3½ to 5 in. in height through which air is continuously passing while the furnace is in operation; thus the radiation from the fire brick arch is utilized for heating the air, which passes into the furnace over the coking plate, and then mixes with the volatile gases at a high temperature. The volatile gases are thoroughly mixed with the air in the highly heated fire chamber, and are completely consumed. The high temperature of air preheated in the fire brick arch assists perfect combustion.

The Howden systems consist of a forced draft apparatus. The air is preheated by being circulated

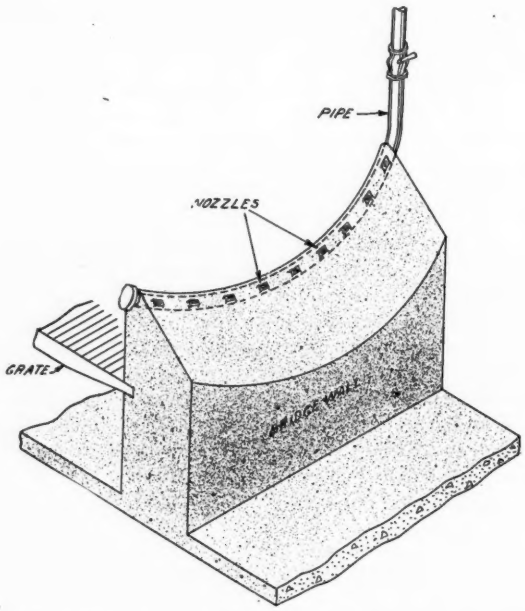


FIG. 2. GRAF SYSTEM OF INTRODUCING PREHEATED AIR, SHOWING NOZZLE ARRANGEMENT

around a series of tubes, through which the hot flue gases pass on their way to the stack. Part of the hot air is delivered into the ash pits and part above the bed of coal into the furnace. By whatever amount the air for combustion is increased in temperature by waste gases, the average temperature is practically raised to the same extent; for instance, say 200 deg. F. is added to the air of combustion by the preheated air, the average temperature and evaporative power of the heating surface is thereby increased. The gases from the burning fuel combine more readily with the oxygen of the air of combustion as the temperature of the fire increased.

A recently devised system of preheating air is that of Anton Graf, a Worcester, Mass., engineer, which is designed to secure the combustion of the gases which ordinarily are wasted in the operation of power boilers. The principle of the appliance is based on the introduction, at the top of the bridge wall of the furnace, of preheated air impelled at high velocity by a steam jet. This results in a complete intermixture of the air and flue gases at a point of highest temperature, the result being a series of reactions in which escaping carbon monoxide and free carbon, together with the hydrocarbons, are converted into carbon dioxide, which means the translation of flue gas energy into heat. The steam serves the

double purpose of preheating the air and of giving it a velocity sufficient to produce a complete intermixture with the furnace gases.

The heat absorbed by the air and that represented in the steam taken from the boiler are converted back to energy in the combustion processes, which means a saving of 25 per cent, in fuel consumption.

Figure 2 shows air introduced through a series of nozzles at the top of the bridge wall to consume the gases ordinarily wasted in a power boiler.

The Johns system is an arrangement whereby fresh air supply is taken in through an air duct which is surrounded by flue gases as they leave the boiler. A certain portion of the flue gas is bypassed from the flue and mixing with the fresh air heats it, and the mixture

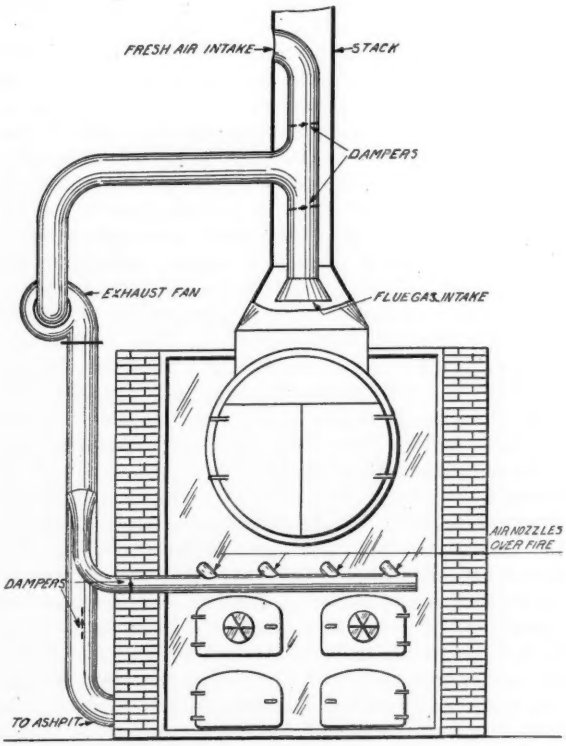


FIG. 3. JOHNS SYSTEM OF PREHEATING AIR AND DISTRIBUTION

is discharged by a circulating fan into the closed ash pit and furnace. Thus a restricted and regulated supply of preheated air can be admitted at will into the furnace.

Dampers are also arranged to regulate the incoming fresh air, the intake of flue gases, and the discharge of air supply to the furnace both through the ash pit and over the fire.

The preheating of the air combined with the method of introducing the air into the furnace, thereby stirring the volatile gases, showed an increase of 14 per cent according to test made by Professor Horace Judd at the Globe Laundry, Dayton, Ohio.

In order to find the required size of air duct for a given grate area, the following rule can be safely applied:

It requires 20 lb. of air per lb. of coal to secure ordinarily good results.

Assume a velocity of 20 ft. per sec. in the duct which will be 72,000 ft. per hr. for 20 lb. of coal per sq. ft. of grate per hour. The volume of 1 lb. of air at 300 deg. F. is 20 cu. ft., for 400 lb. it will be $400 \times 20 = 8000$ cu. ft. per hr.; $8000 \div 72{,}000 = 0.11$ or 1/9 sq. ft. of air duct for 1 sq. ft. of grate surface.

President Wilson May Enter the Power Plant Field

CONGRESS has passed a bill authorizing the President to build a power plant or plants at any place in the United States as he may deem necessary, up to a cost of $175,000,000, to produce gas, coke, toluol, benzol, coal tar and other useful products. He is also authorized to install appliances or machinery in any private plant to increase its capacity or production, and to lease the machinery to the owner during the war and up to 5 yr. thereafter.

He can advance money to the operator of any plant to equip or expand it, arranging time and terms of repayment up to a period of 5 yr. after the end of the war.

He may acquire any private plant by purchase, requisition, condemnation or lease, may combine two or more plants and construct transmission lines and deliver power to such persons and at such rates as he may deem proper.

He may requisition all or any part of the power from a private plant during the war, may modify, cancel or suspend any contracts, present or future, for power to persons not engaged in producing war material.

He can form corporations to purchase, build or lease power plants, and can sell or exchange plants when, in his opinion, the interests of the country warrant it. If machinery installed by him in a private plant or one to which he has taken title is an integral part of the plant or necessary to economical operation, the owner of the plant may buy it at a value to be determined by agreement or arbitration.

In paying for plants acquired, just compensation is to be made in amount and manner prescribed by the President, and if the owner is dissatisfied, 75 per cent of the amount determined by the President shall be paid, and the owner may sue the United States for an amount which, added to that 75 per cent, will make up what he deems just compensation.

Any person who neglects or refuses to comply with an order or requisition of the President, who tries to obstruct enforcement of such order or who tries by fraud to induce the President to lend or advance money, shall be punished by a fine of $5000, or imprisonment of not over 2 yr., or by both.

Appropriation of $150,000 is made to cover administrative expenses, and $175,000,000 for construction, acquisition, maintenance and operation of plants. All revenue from lease or operation of plants and transmission lines is to be deposited in the United States Treasury to the credit of the appropriation.

Thus is the President, at one stroke, placed in position to become the chief power-plant magnate of the country—at least during the war and for 5 yr. afterward.

Fuel Economy in Hand Fired Boilers---III*

Loss of Heat Value

THE PRINCIPAL losses entailed in the process of combustion may be divided into the following classes:

(1) Loss due to excess air and air leakage through the setting.

(2) Loss due to combustible in ash.

(3) Loss due to CO formed.

(4) Loss due to soot on the tubes.

(5) Loss due to moisture carried in with the coal and air.

(6) Loss due to heat carried out by the escaping gases.

(7) Loss due to radiation.

Losses included under classes 1 to 4, inclusive, are largely preventable, while those under classes 5, 6 and 7 are more or less inevitable, although they may be reduced to a minimum with proper care.

Excess Air and Air Leaks

THE SPACE inside the average boiler setting is at less than atmospheric pressure; hence if there are any openings in the setting, air will leak through from the outside. This cold air not only takes no part in the combustion, but its temperature must be raised to that of the rest of the gas, a process which requires heat and lowers the temperature of the other gases. Some of this heat is given back to the water in the boiler, but all that indicated by the difference between the temperature of the flue gas and that of the air in the boiler room represents a dead loss. This is also true of the excess air carried through the fuel bed. While these losses cannot be detected with the naked eye, like that due to green coal in the ash, they are by far the most serious of all losses occurring in the average plant.

Leaks in the setting may occur in the metal work around doors and joints as well as in the brickwork. When leaks are found they should not only be stopped with asbestos or stove putty, but should be calked with waste or asbestos fiber soaked with fireclay in such manner as to prevent cracking off or falling out as soon as dry. The last of the leaks may best be found by building a smoky fire and shutting the damper. Smoke may then be seen to issue wherever there is a leak. When the setting has been made as tight as possible, air will still seep in because the bricks and the mortar are porous. This leakage may be reduced to a minimum by tacking metal lath to the setting and applying a coat of plaster one inch or so in thickness made of a mixture of about 80 per cent magnesia and 20 per cent old magnesia pipe covering. In order to secure a satisfactory surface 85 per cent magnesia should be mixed with cement to form a thin grout, spread on the surface, troweled to a smooth finish, and painted. This makes a good lagging not affected by temperature changes and also serves to reduce the radiation loss listed under class (7). If the setting is too hot to permit touching it with the hand without discomfort, the radiation loss is excessive.

After the setting has been made absolutely tight it will pay to give attention to the excess air loss, but it is well to emphasize that the former should be done first. There exists a very definite relation between capacity, draft, fuel bed thickness, and air passing through the fuel bed with a given grade of coal. For Illinois coal a draft of approximately 0.01 in. of water is required to burn one pound of coal per square foot of grate surface per hour. This ratio is slightly increased for rates of combustion above 25 lb. of coal per square foot per hour.

In order to determine these relations in any given plant, a time should be chosen when the load on the boilers will remain constant for several hours. The fire should be clean, of uniform thickness, and free of holes, and the surfaces of the tubes should be free of soot. A draft and fuel bed thickness sufficient to maintain the load without loss of pressure should then be chosen. Simultaneous readings of the draft and analyses of the flue gas should now be made as rapidly as possible and repeated at brief intervals to insure permanence of conditions, and a watch should be kept on the fire to see that holes do not develop. Care must be taken not to open the furnace doors during a reading. Records should be kept of the drafts, CO_2, and fuel bed thickness. Thickness of fuel bed should then be varied and the draft adjusted to carry the load without pressure drop, or without blowing the safety valves. When sufficient time has elapsed to allow conditions to become constant, another set of readings should be taken. If too thin a fuel bed were used at the start, it will be found on comparing the readings that as the thickness of the fuel bed is increased, the draft increases, and the percentage of CO_2 also increases. Finally a point will be reached at which the CO_2 does not increase further as the thickness of the fuel bed and the draft increase. The draft and fuel bed thickness to give this CO_2 reading represent the proper values for the given load on the boiler, under which the suggested changes in operating conditions have been made. This process should then be repeated for a number of different loads on the boiler. Upon doing this it will be found that with a given thickness of fuel bed, certain more or less well defined limits of draft over the fire will give a maximum CO_2 reading. The draft then becomes the key for controlling the whole situation. If the load on the boiler is such as to require drafts between certain limits, then the thickness of fire which should be used is immediately known, provided there are no holes in the fire and the tubes and fire are clean. These latter conditions will be indicated by the differential draft gage readings of which should also have been taken during the tests when the tubes were known to be clean and the fire in good condition. A table or chart should be laid out for the use of the fireman, which, as soon as the approximate draft necessary to maintain boiler pressure is known, gives the thickness of fire to be carried and the corresponding differential draft gage reading. If the fur-

* Abstract of Circular No. 7, entitled Fuel Economy in the Operation of Hand Fired Boiler plants, by the University of Illinois Engineering Expriment Station.

nace draft and thickness of fire are correctly maintained and the differential is then too low, it indicates either that the fire is dirty or that some of the baffling has fallen. A too high reading of the differential indicates that there are holes in the fire, or that soot is clogging the passages through the tubes.

The thickness of the fire should not be left to the judgment of the fireman, but definite marks should be placed on the inside door liners, or at some points where they may be seen. In any case, it should be thoroughly understood that the co-operation of the fireman is necessary, and unless the fires are kept clean, and the firing is done in such manner as to maintain a uniform fuel bed without holes the other precautions suggested are useless.

Since air leakage through the setting tends to increase as the draft increases, it is good policy to run on the minimum draft which will carry the load without pressure drop. The CO_2 readings are a direct indication of the total loss due to both excess air and to air leakage when taken just below the damper.

The draft should be controlled by means of the dampers at the flue, and not by the ashpit doors. Closing the ashpit doors prevents air from going through the fuel bed, causes clinker and hot grates, and also increases the air leakage loss. Each boiler should be equipped with a separate damper and the position of maximum and minimum damper opening should be determined. The damper should then be operated between these limits. The points of maximum and minimum opening should be found by noting the reading of the draft gage while the damper is moved from one extreme position to the other. These points of maximum and minimum draft gage reading may not coincide with the points at which the damper is mechanically open or closed. A position will usually be found at which the draft is maximum, and a further opening of the damper will not change the reading. It may also be found that the damper can be opened quite appreciably before the draft gage begins to read. In many plants of large and medium size, automatic draft control has proved economical and it is also of advantage in maintaining constant steam pressure. If automatic control of the draft is used, it is important to have the damper adjusted for the range of travel determined by experiment as suggested, so that the draft will be proportional to the opening. An automatic damper regulator, when used, should preferably be of the type which responds to small decreases or increases in steam pressure by causing a corresponding movement of the damper. If there are several boilers in the plant, the best plan is to adjust the individual dampers so that each boiler is carrying its share of the load under the most economical draft, and then, if the total load changes, to regulate with a master damper in the main flue.

Loss Due to Presence of Combustible in Ash

The loss due to partly burned coal in the ash should not, with very careful handling of the fire, exceed more than about three per cent of the heat value of the coal. Excessive carbon in the ash with stoker fired furnaces usually indicates too rapid feed for the rate of combustion used. In hand fired furnaces it may indicate that the grate openings are too large for the size of coal used or that the fire is worked too much, or both. So far as possible the fire should be operated without much working except at times of cleaning. In working a fire, it should be sliced from the bottom in such a manner as to avoid or minimize the possibility of forcing ash up into the fuel bed. This applies to stoker firing as well as to hand firing.

Loss Due to Presence of Carbon Monoxide in Flue Gases

Carbon monoxide is formed if too thick a fire or an insufficient draft is used. With central bituminous coals there is little possibility of large loss from this source if the CO_2 reading is not more than 12 per cent.

Loss Due to Soot

The largest part of the loss due to smoke does not result from the fact that the particles of carbon floating in the gas stream have passed out before giving up their heat value, but it comes from the deposit of soot on the tubes. The actual heat value of this deposit of soot is small when compared with the amount of coal fired in producing it, but its power of preventing the heat in the gases from reaching the tubes and being absorbed is a factor of considerable importance. Soot makes an excellent heat insulator. Under normal working conditions and with the normal amount of air, the temperature of the gases leaving the boiler should be somewhere near 550 deg. F. If they leave at a much higher temperature and the fire and drafts are normal, it signifies that the tubes need blowing. The soot deposited on the heating surfaces is keeping the heat in the gas from reaching the water and the gases consequently are not cooled. Where automatic blowers are installed the tubes should be blown every 4 or 5 hr. In all cases they should be blown at least once for every shift. A pyrometer placed at the point where the gases leave the tubes for the last time will give a fairly good indication of their condition, provided of course that low temperature is not due to excess air.

Loss Due to Moisture in Coal and Air

The loss due to moisture in the air is very small and need not be considered. That due to moisture in the coal may be larger. The coal may carry 13 or 14 per cent of moisture, and the heat required to evaporate this must be furnished by the coal itself, thus decreasing the amount available to heat water in the boiler. Fine coal tends to pack if fired dry. This prevents the proper amount of air getting to the fuel, and results in the formation of carbon monoxide and in cold fires. Sometimes very dry coal burns out unevenly, and will not stay on the grates without allowing holes to form. For these reasons, it is advisable to wet down the smaller sizes of coal just before firing because the other losses mentioned are greater than that due to the water. With larger sizes wetting is not necessary and is not advisable. This, however, must be decided for each individual plant. In no case should more water be added than is absolutely necessary.

Loss Due to Heat in Escaping Gases

Every pound of flue gas passing up the stack represents a loss of about 0.24 heat units per degree F. above the temperature of the steam in the boiler. This loss

cannot be entirely eliminated. For plants operating on natural draft, a temperature of about 500 deg. F. is required in the stack to produce the draft necessary to operate the boilers at full capacity. An average of 550 deg. F. is good practice. For forced draft and four-pass boilers, it may run lower than this temperature. An indicating pyrometer should be used on each boiler and if the temperature in the flue becomes abnormally high it may be accepted as an indication of an excessive deposit of soot upon the tubes or of a draft greater than is necessary for the load.

Loss Due to Radiation

Uncovered surfaces and other surfaces which are too hot to touch without discomfort represent a serious loss of heat. This loss can be decreased by covering the setting as previously suggested.

Methods of Hand Firing

There are two general methods advocated for hand firing, (1) Coking, (2) Spreading. The first involves the placing of a considerable amount of green coal on some convenient part of the fuel bed where the heat will pass into it and will slowly distil the volatile gases. These gases then mix with air above the bed and in passing over the white hot bed are burned before they reach the cold surfaces. The method usually adopted is to pile the green coal at the front of the bed. After 10 or 15 min., during which the coal has become well coked, this pile is broken up and spread over the back part of the fuel bed, and a fresh charge is piled at the front. This method accomplishes satisfactory results so far as smokeless combustion is concerned, but it does not promote efficiency. The keynote of efficiency lies in the maintenance of a uniform fuel bed, while with the coking method of firing the bed burns unevenly. The bed is usually too thick at the front, and burns out and develops holes at the rear, and although it is less liable to form clinker, this practice is not to be recommended as highly as some form of spreading.

In the spreading method, small quantities of coal are fired at frequent intervals. In alternate spreading, a thin layer of coal is spread on one side of the furnace. As the gases distil, they mix with the air, and the white hot surface on the other side maintains the mixture at the ignition temperature. After a period of about 5 min., when the distillation is complete, another charge of fresh coal may be spread on the other side of the bed. By this method the fire may be kept in a more nearly uniform condition than by coking. Where the coal is spread over any considerable area, however, there is still a tendency for the resistance at different parts to vary, and for holes to develop.

The best method is to fire very often and in small quantities. Holes should not be permitted to develop; to prevent holes, small amounts of coal should be placed on the thin parts of the bed. Thin places may be recognized from the fact that they appear brighter and hotter than the rest of the bed. This method requires more attention on the part of the fireman, but it pays in the long run. It is possible to maintain a uniform bed for long periods without barring or working the fire. Where the coal is fired in small quantities, the volume of combustible distilled at one time is small and may be easily consumed over the hot part of the fuel bed without forming smoke.

In any case, in hand firing, it is necessary that some auxiliary air be taken in over the fuel bed for several minutes immediately after firing. This should be admitted across the fire close to the surface of the fuel bed, preferably from the front through auxiliary dampers in the fire door, which should have an area of at least 4 sq. in. per square foot of grate surface. This admission of air may be accomplished either automatically or under the control of the fireman. The automatic device opens small supplementary dampers when the fire door is opened, and then closes them gradually after the door is shut. The time of closing is usually about 3 min. The same result can be accomplished by the fireman regulating the dampers in the fire door by hand. In some cases the use of a steam jet immediately after firing has proved advantageous, since it not only carries in the air necessary for the combustion of the volatile gases, but also serves thoroughly to mix the air and gases.

Why You Should Save Paper

Sulphur is used in the manufacture of practically all kinds of paper.

It is used in the form of sulphur dioxide.

Our government needs great quantities of sulphur for war munitions.

Much of this is used in the manufacture of gas to be used in warfare.

Germany began the use of poison gas in warfare.

It is necessary to fight back with the same weapon.

Otherwise our soldiers will be needlessly sacrificed.

We make a better gas, one that is deadlier and drives back the enemy more efficiently than any gas they have.

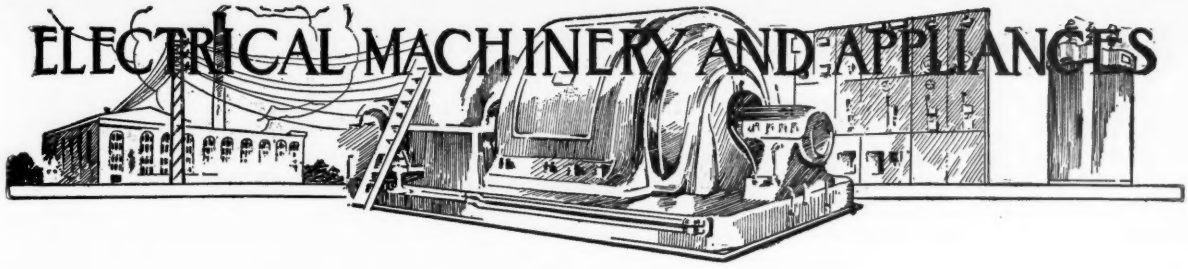
Every piece of paper contains a certain amount of sulphur.

There are only two sulphur mines in America.

There is not enough sulphur for both the great quantities of gas needed and the tons of paper that we thoughtlessly waste.

Every sheet of paper, every bag, every bit of wrapping paper, every sheet of letter paper we save by not needlessly using or by not thoughtlessly wasting allows just so much more of the precious sulphur for our war use. Save the paper and help choke the fiendish Hun at his own choking game.

In south africa electricity is used extensively for power in the mines, partly generated at the mines, partly supplied from public central stations. For the gold mines in the Transvaal, 226 dynamos are installed having total capacity of 67,625 kw. and 5713 motors with rating of 397,620 hp. For diamond, coal and basic mineral mines, the dynamos are, respectively, 61, 75 and 30, with total capacities of 17,878, 8393 and 2958 kw. The corresponding motors are 695,288,213, with horsepowers of 24,569, 6169 and 4523. In industrial work, there are 630 dynamos with capacity of 223,882 kw. and 4835 motors of 115,315 hp. rating. In Cape Province, Orange Free State and Natal, there are smaller but very substantial numbers of dynamos and motors, making the total for South Africa, 1022 dynamos with capacity of 320,736 kw. and 11,744 motors with rating of 548,195 hp.



Tests for Locating Armature Trouble

ALL COMMON ARMATURE DEFECTS DETECTED BY ONE-MAN BAR TO BAR AND GROUND TESTS WITH VOLTMETER AND BANK OF LAMPS

A RELIABLE test can be made on armatures by means of a bank of lamps connected in multiple from some outside direct current source in series with the armature to be tested, by using a direct current millivoltmeter or ammeter as shown in the illustration making a bar to bar test which will locate short circuits, open circuits, reversed coil and at same time show the condition of the soldered connections between the coils and commutator bars.

This discussion is devoted entirely to wave windings of the single circuit type and not to adjacent connections.

Direct current from an outside source is passed through the armature by means of contacts applied at

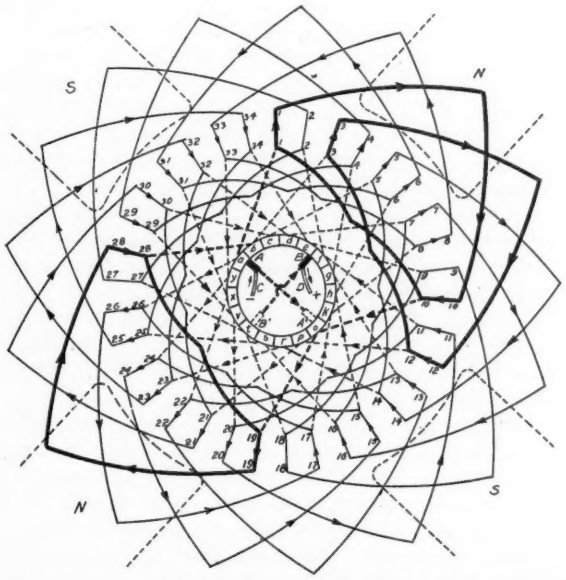
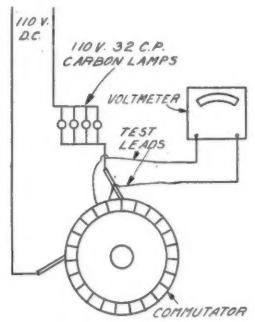


FIG. 1. FOUR-POLE, SINGLE CIRCUIT TYPE, WAVE WINDING DIAGRAM

two points the distance between which is the same as that between any two adjacent brush holders when the armature is in operation. For a four pole machine where the leads connect on the quarter of the commutator, the outside source must be supplied on the quarter. In the illustration, Fig. 2, the millivoltmeter is provided with flexible test leads. A bar to bar test is made by placing the loose end of one lead on one bar and the loose end of the other lead on the adjacent bar and continue on by shifting the leads from bar to bar as the readings are taken. The value of the current is adjusted by trial until the deflection desired is obtained. For instance, if we have a millivoltmeter or ammeter with a 50 point scale deflection and by applying the current through six lamps in parallel we find the scale deflection to be 45 points, we cut one lamp out of the circuit and trying the reading again and continue doing so until a scale deflection is obtained, say about 25 points, which will allow the tester to obtain a good variation if any in the windings.

Should, on the other hand, the reading be too low to get an appreciable scale deflection, more lamps may be inserted until the desired result is obtained. If the scale deflection is too great with all but one lamp out of circuit, the only thing to do is to use an external shunt



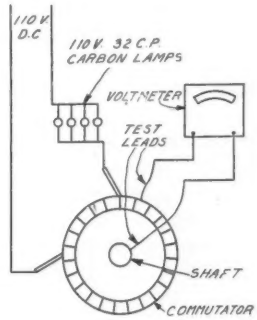


FIG. 2. BAR TO BAR TEST SHOWING VOLTMETER (V) TEST LEADS AND LINE LEADS WITH LAMPS

FIG. 3. GROUND TEST WITH LINE LEADS IN POSITION AS BAR TO BAR TEST

on the instrument and adjust this shunt by increasing or decreasing its size or length as called for. For instance, use a piece of number 20 B. and S. gage wire about 10 in. long for a shunt, should the reading be too high, cut the length down until the desired reading is obtained, should the reading be too low, try smaller size wires until the desired defleetion is obtained.

If the machine is connected on the quarter, meaning that one lead of the coil is connected to bar 1 in an 80 bar commutator and the other lead of the coil is connected to bar 20, the armature is said to be connected on the quarter; the line leads should be placed on the quarter. In testing for short circuits, it is generally assumed that the resistance of properly soldered con-

nections is negligible. Since the amount of deflection depends on the resistance of the coils that are spanned and on the strength of the current flowing, any variation of the drop obtained on sets of coils successively tested will be due to variations in the resistance of those sets of coils. Very slight variations in deflection will be unavoidable, because no two sets of coils are likely to be exactly alike, nor is it usually practicable to keep the current absolutely constant, since there are often loads put on or taken off the same line supplying current to the armature. Any serious variation in the resistance of a coil, such as that caused by a short circuit of some or all the turns of a coil, or set of coils, or by a short circuit between two or more coils, or by poorly soldered lead connections, will be indicated by an unmistakable discrepancy in the meter readings. In case of an open circuit, when the test points are placed across the two bars between which an open circuit exists, the reading of the instrument will be extremely high, oftentimes throwing the needle violently against the limit stop, which is liable to injure the instrument as the drop of potential across a single armature path is much greater than the drop across a set of two coils. If, on applying the test leads to adjacent bars on one side of the armature, the deflection is uniformly too great, and the deflection is zero when the test leads are applied to adjacent bars on the other side of the armature, indications point to an open circuit in the winding, which must be removed even if only temporarily or short circuited by means of a jumper before the low reading instrument can be used without liability to injury.

In making the bar to bar test by this method it is necessary to keep one of the contact points always in the lead, for if you advance by stepping one lead alternately ahead of the other the meter readings will be reversed at each step. This fact is taken advantage of to indicate a reversed coil, for when the test is made with one contact point always in advance between points of normal reversals the current through the meter is uniformly in one direction; if, however, a reversed coil is encountered, the current through the meter is reversed.

For a ground test, the line leads are left on the commutator, as with the bar to bar test, one end of the meter leads are placed on the commutator and the other end on the armature shaft. If no scale deflection is seen on the instrument, the armature is not grounded. If the armature is grounded, the instrument will show a deflection, depending on the degree of the ground.

Illumination

SOME INTERESTING DEVELOPMENTS AND PROSPECTS FOR ILLUMINATING ENGINEERS IN ENGLAND. BY MARK MEREDITH

TO THOSE observant and appreciative of industrial progress, the greater attention which has been given to the subject of illumination during the past decade will not have passed unnoticed. In every sphere of life—industrial, commercial and domestic—modern illumination stands in a vastly improved position from that of 10 yr. ago. In this matter Great Britain had to some extent to follow a definite lead given by America, where organization was being effected to bring about more efficient methods of lighting with multitudinous advantages.

Arising immediately from a visit to the United States and consultations with leading experts on illumination, a definite attempt was made, through the initiative of Leon Gaster, to form an illuminating Engineering Society in Great Britain, and recently Mr. Gaster presented to the Society a resume of the progress which had been effected, and outlined the immediate needs and prospects.

From the outset it had been apparent that the subject would need to be handled on the broadest possible lines, uniting, as it does, the interests of the gas and electrical industries, and affecting the welfare of all classes of manufacturers and consumers. While the object of the Society was of a very specialized character, success could not be attained apart from the active co-operation of many other bodies. While essentially a scientific society, data from all sources had been sought and obtained, and no professional qualification had been imposed upon the members, thus effectively bringing together representatives of scientific and industrial thought, and impressing the lay mind with the urgent importance of the subject. The harmonious co-operation of representatives of rival illuminants and the broad character of the society's work had acted as a corrective to undue specialization by providing a platform from which all aspects of the subject could be freely discussed.

One of the most obvious advances which had resulted from this effort was that, although more light was undoubtedly used than formerly, much more concern was manifested as to the manner in which it was used. In place of mere brilliancy of illumination, much more attention was being given to contrast with surroundings, direction of light, and avoidance of glare, and appropriate shades, reflectors, and globes are now marks of efficiency in illumination. Progress, too, had been effected in the subject of illumination photometry. In another direction the formation of the society anticipated one ultimate result in the development of the illuminating engineer. Though the need was being more fully recognized, it had been necessary to await the acquisition of the wider knowledge of lighting problems, and to create a more general appreciation of the subject, in order to encourage men to specialize in this branch of applied science.

All are, in a general way, agreed as to the benefits of good illumination, but the accumulation of statistical evidence cannot fail to emphasize the necessity for greater attention to the subject. On this count, it can be unequivocally stated that good illumination pays. In a recent publication of the Ministry of Munitions Committee on "Health of Munition Workers," it is affirmed that, "The results of inadequate illumination are, damage to eyesight and personal health, various form of domestic insanitation, accidents to factories and workshops, often accompanied by diminution in output of work and the lack of discipline. Bad lighting affects output unfavorably, not only by making good and rapid work more difficult, but by causing headaches and other effects of eyestrain. Attention should be paid to the lighting of passages, offices and the immediate surroundings of the factory, as well as that of the factory itself." To some, diminution of output may appeal very strongly, but of greater importance is the matter of health of

the workers, so essential from a national point of view, and without which maintenance of output could not be secured. Further light on this point could be gained by taking advantage of the present conditions to institute reliable comparisons of the effect of illumination on output in factories in which identical operations are being carried on but under greatly varying conditions of lighting. Direct evidence of the economic value of good lighting would thus be at once forthcoming. Some effort towards the collection of such data is now under consideration. Of great importance, too, is the matter of the lighting of schools. Here the eyesight of the coming generation is being preserved or deteriorated. Especially urgent is the matter at this period of development of the child, when eyestrain due to defective conditions is so probable, and the closest attention to illumination cannot fail to have attendant benefits which may be more apparent in a few years' time than at the present. The need for statistical inquiry into the causes of blindness and the separate treatment of myopic and partially-sighted children has been advocated by a Departmental Committee on the Welfare of the Blind. The lighting of such schools should especially be a matter for the expert illuminating engineer.

"Few people realize that the number of street accidents in Great Britain every year exceeds the number of those who formed the original Expeditionary Force to France in the present war, while, in factories, roughly 160,000 accidents were reported in 1913, of which 1287 were fatal. That these could to some extent be avoided by more effective lighting admits of no doubt, and every effort on the part of those directly concerned with the lighting of streets, factories, and with traffic and workshops organization should be made to minimize the dangers. In order to accomplish this more effectively, Mr. Gaster strongly advocates simple, yet adequate, compilation of statistics regarding street and workshop accidents. One remembers only too well the enormous increase of street casualties due to the lighting restrictions, and the fact that more recently better illumination has been conceded. But further steps should be taken both during and after the war to correlate the causes, and minimize the dangers attendant upon a largely increased output in the factories and traffic congestion in streets.

In order to carry on the work which has so effectively been begun in the direction of illumination, definite aims of an educational character must be pursued. Already numerous branches of engineering need augmenting by that of illumination. Some attempt on a limited scale has been made to organize courses of instruction in this highly specialized branch of engineering. The great advantages accruing from knowledge of other departments of engineering at once attracted a large number of workers and students. Wireless telegraphy may be quoted as a case in point. An active propaganda to educate public opinion will need to accompany the training of men as illuminating engineers proficient in the knowledge of all principles and in a position to advise upon, and to direct, the installation of efficient lighting appliances. Once a definite move is made in this direction a demand will arise for suitably trained men. It would also seem not improbable that courses of instruction should be especially designed for women, who could subsequently act as advisers in domestic circles. On the educational side, reference may be made to a very comprehensive series of lectures delivered at the Pennsylvania University last autumn.

In order to attain the higher ideals fuller opportunities will be necessary for co-operation between scientific and technical societies and the state. Several government departments have already sympathetically received suggestions which have been issued, and the home office has shown enterprise in appointing a Departmental Committee on Lighting in Factories and Workshops, which issued its first interim report in 1915. At the conclusion of the war and during the period of reconstruction many areas will need to be rebuilt and towns planned, and the street lighting plans in many of the large towns in Great Britain which were beginning to be put into effect at the outbreak of hostilities will demand immediate attention. Wide scope will thus seem to be offered for the application of up-to-date knowledge of the science of illumination. If the early attention of illuminating engineers has been more directly given to the causes of defects of, and improvements in, lamps and fittings, it is certain that in the near future greater attention will be given to the effects, hygienic, economic and artistic. The lighting engineer of the future will co-operate, and not compete, with the architect and contractor. Present knowledge must be reduced to practical shape, and its value demonstrated beyond dispute, and as a matter of national importance it should be nationally encouraged.

An institution with these worthy aims, with achievements such as those now placed on record, and which touches so many phases of commercial and domestic life, has not only justified its existence but has abundantly demonstrated the appropriateness of its title in emphasizing the science and practice of illumination as a definite branch of engineering.

Motor Rating and Capacity

By Herbert A. Barry

"RATING" and "Capacity" are entirely different things and need not necessarily bear any definite relation to one another. The rating of a motor is the horsepower output which the motor will develop when operating under certain conditions definitely specified by the manufacturer of the machine. The capacity of a motor is the maximum output which the motor will safely handle. For example, a motor having a rating (on the basis of a certain manufacturer's guarantees) of 10 hp. will develop 10 hp. continuously without any of its parts becoming heated more than 40 deg. C. above the surrounding air. However, this same 10 hp. motor might have a capacity of, say, 13 hp. for continuous operation. That is, the motor might pull a 13 hp. load continuously without becoming so hot that its insulation or other parts would be injured permanently. As a rule, however, it is usually unsafe to operate a motor at loads much greater than that for which the motor is rated, because the motor is guaranteed by its manufacturer on the basis of this rating.

Consider an analogous situation which obtains with motor trucks. A so-called two-ton truck may be regarded as having a "rating" of two tons. This means that its manufacturer guarantees that it will safely

handle a two-ton load. However, from experience, it might be found that the owner of one of these so-called two-ton trucks would find that the truck would actually safely handle loads of 2½ tons, in which case, following out our analogy, the "capacity" of the truck would be 2½ tons.

Effect of Change of Frequency on Induction Motors

By A. B. Berkeley

If a 25-cycle machine is operated on a 60-cycle circuit the speed will be increased at a ratio of 25 to 60. For example, a two-pole motor which runs at 1500 r.p.m. on a 25-cycle circuit would run at 3600 r.p.m. on a 60-cycle circuit. Due to excessive centrifugal stresses, such an increase in speed might introduce excessive strains in the rotor. The normal capacity of the 25-cycle machines will be about the same on a 60-cycle as on a 25-cycle circuit. The pull out point will be decreased and the starting torque will be materially reduced.

If a 60-cycle induction motor is operated on a 25-cycle circuit it will require possibly 2½ times the magnetizing current for 25 as for 60 cycles. In general, the effects would be excessive heating of the machine, a reduction of its speed in the proportion of 60 to 25 and reduction in its capacity and low power factor. While in certain instances 25-cycle motors have operated with fair satisfaction on 60-cycle circuits, it is not probable that a 60-cycle motor would give satisfaction on the 25-cycle circuit.

Speeding Up Machinery Production

HARDLY a day passes in the Essington works of the Westinghouse Electric and Manufacturing Co. at South Philadelphia that some one of the many departments in those shops does not make a new record in the production of ship propelling machinery. Although this factory has not yet been completed a year, and will not be able to operate at full capacity for some time to come, in production the shops are already ahead of their schedule.

Handicapped by its requirement for labor, the company is adding as rapidly as possible to its force of female workers. It has just commenced to operate part of the blading section in the turbine department by women, who are being taught to use the file, the chisel, the punch and the hammer in their efforts in helping to win this war. Other women have been engaged for the steel metal working department, and they are turning out sheet steel boxes and lockers the same as the men used to do. So far, the introduction of woman labor in these works has proved quite successful. The condenser girls, who have now been at their jobs for over two months, made good almost from the start, and they are becoming more expert every day.

Speaking of production, it was officially stated, that the press crew in the forge shop, consisting of twelve men and working on the 1000-ton hydraulic press, which produces steel forgings for turbine and reduction gear axles, for ship propeller shafting and tail shafting, increased its output every day last week, from 83,000 lb. on Monday until it reached the maximum record for daily production on Friday by turning out 105,000 lb. of steel forgings. In the foundry the average output per day now amounts approximately to about 300,000 lb. of gray iron.

When the works will be running at their full capacity, they are expected to turn out one complete vessel equipment of marine power machinery a day, consisting of steam turbines, reduction gears, condensers, pumps and other auxiliary machinery.

The Ordnance Department announces the appointment of W. W. Coleman and T. H. Symington as special assistants to the Chief of Ordnance. Mr. Coleman, who has been president of the Bucyrus Co., of South Milwaukee, Wis., will have charge of all matters connected with the production of cannon, carriages and their appurtenances and accessories. Mr. Symington, who is a member of the firm of Symington-Anderson Co., of Rochester, N. Y., will have charge of artillery ammunition, metal components, but will have nothing to do with the loading plant operations.

This appointment of Messrs. Coleman and Symington is in line with the recently announced reorganization of the Ordnance Department. Under the plan adopted, the Chief of Ordnance will have about him special assistants, each of whom will have general supervision over all phases of work connected with the manufacture of some one branch of ordnance material.

Major General C. C. Williams, chief of ordnance, has written the Single Service Package Corporation of New York City, commending the employes of that plant for having attained a production speed of more than 100 hand grenades a minute.

While the production at this and other plants was in the midst of the speeding-up process, enemy influences in this country began spreading reports to the effect that the "offensive" hand grenade being turned out by this company was not effective, and that persons employed in plants manufacturing them were wasting their efforts. General Williams, in his letter to the company named above, takes occasion to deny this. He said:

"My attention has been called to your letter of recent date, addressed to Capt. E. T. Caldwell, of this department, in which you report that the production of offensive grenades at your plant has now been set at 6200 an hour, and that you have already completed and shipped your third million of these grenades.

"I cannot refrain from expressing to the workers in your plant, through you, my admiration for their achievement and my very deep appreciation of the loyalty and devotion to country which has inspired them in their efforts. The manufacture of these grenades is of highest importance to the men who are fighting in France, and no more pernicious propaganda has been set afoot in this country than that by which the enemy hopes to discourage the men who are producing this material in this country. The fact that your employes have so completely shut their ears to this insidious campaign of falsehood must be a source of chagrin to the enemy's agents."

The maximum production was attained Friday, Sept. 13, when 55,200 grenades were turned out.

Training the Boy for Industry*

ANALYSIS OF TRAITS AND QUALITIES WHICH INDUSTRY REQUIRES AS SHOWN BY INDUSTRIAL EXPERIENCE. BY LOUIS L. PARK

TO a large percentage of the boys who each year reach legal working age the call to enter industry comes with a strong appeal, the appeal of a great new experience. It offers a change from the routine of school life and a freedom from study; it offers the charm of an income and of more spending money, a feeling of independence and an improved standing among one's neighbors. Others have succeeded, have secured good jobs and earn good wages; why may not they? It is the call to a big adventure in which are wrapped the possibilities of the future. Were we to ask these boys what is the most important thing to be attained through industry it is likely that from most of them we would receive the answer "good wages." * * * But industry holds more for these boys than a chance for financial gain; it gives to many the opportunity for that development of mind and body which leads to broader interest and to increased ability, and their activity in matters of social interest is partly the result of success as industrial workers. The larger relationships of industrial life present also the problems of moral development, either for better or for worse, for with the associations which come with work in mill or shop come moral influences which help for the strengthening of character or which tend to lower the standards. * * * If the boy who is to enter industry is to be prepared for life, much will depend, then, upon how he is prepared for industry and the extent to which our schools prepare the boy for industry will in many cases mark the extent of their influence in shaping him for life in a democracy.

The vocational training of boys for industry can be considered in a general way only. So varied are the demands of industry, so many the degrees of opportunity offered and so different the provisions made for training after employment, that no simple rule can be suggested. The needs of each locality will naturally govern to some extent the vocational training advisable, and the preparations which the employer makes will modify those needed in the school for the training of the future worker. Still further, there is the problem of adjusting the individual to his proper task, of finding the work which will afford development and provide income to the satisfaction of the worker. These variables must be met by a program sufficiently flexible to insure justice to the greatest possible number.

We may well keep in view the fact that most industrial workers eventually specialize in their work, no matter how elaborate their training. The young man finds that he does his best work and makes the best wages in some one process, and to this he is apt to hold, while only a few engage in work involving broad training and demanding general skill. The instruction given to employes after entering industry is, therefore, part of a program of adjustment which is necessary to enable the worker to find his ultimate job.

All specialization is most intelligent and appropriate if it has been preceded by a program of training in different operations. The apprenticeships and other training courses offered by employers have this as one of their objectives, not only to develop men for general utility, but to give the mental development which produces efficiency in the worker. Several things are here accomplished: First, the worker's curiosity as to certain kinds of work is satisfied in the process of rotation about the shop and he is content afterward to settle down to one of them; if confined to one task from the start he is apt to think some other is more attractive and keep changing later to less advantage. Second, he is better able to judge the work to which he is adapted, because of his all-around experience. Third, he is mentally broader and more ingenious and self-reliant from his contact with many problems and their solution and his mastery of a number of processes. Fourth, he has less fear of specialization, since he knows his ability to do other things, if necessary, and there is absent a feeling of narrowness due to the confining character of his task. If variety of opportunity is not provided it will, in many cases, be obtained by voluntary drifting, and it may well be given by plan at first than by accident later.

Whatever the school may do in vocational guidance should help to decrease, though not eliminate, this post-employment fitting of boys to jobs and jobs to boys. The thing he likes best may eventually be set aside and another more serious task may claim his life's greatest effort, but with the larger number the guidance of the school will prove to be safe and, in many cases, final.

When a modern training course is offered by an industrial concern, the matter of preliminary training is simpler. * * * When proper training in industry is not provided, the vocational opportunity of the schools is apparent. To a greater or less extent they may prepare for specific positions or trades and give the student the breadth of experience which should always precede specialization. They may at least teach the essential operations of certain predominant trades, or what we may call the "alphabet" of the trades, from which are derived the many combinations which make up a variety of industrial occupations. With these fundamentals mastered it will be easier for the student to adapt himself to a specific situation than if he has attempted to specialize in school and must later take up other work.

But, whatever may be the extent of trade or vocational training before the boy enters the shop or mill, there are certain mental traits which, if he has acquired, will help toward successful progress in industry. He may have gone through the school program and done all the stunts required and be able to show some samples of his productive ability, but yet miss the most desirable of things possible of accomplishment. The state of mind is, after all, one of the great things desired—the attitude of the boy toward his future work. His conception of the scope of his school training, his ability to adjust himself to his work, his reaction under discipline, his sense of the relation of quality and quantity, and his attitude

* From an address delivered before the department of vocational education and practical arts of the National Educational Association and as published in The Vocational Summary.

toward compensation will have much to do with his progress toward efficiency. The extent to which the school may help in shaping his attitude toward these is problematical, but whatever it may be able to accomplish in this direction will be desirable. We have known boys to consider their school trade training as sufficient to insure a substantial income and who have drifted from place to place because it did not soon materialize. We believe that it is unwise for anyone to encourage boys in considering themselves skilled mechanics when they have mastered only the elements of a trade, yet there is a tendency, even though an unconscious on, for this to occur. A realization that his training has been a preparatory one will usually help the boy to appreciate better the requirements of his real job.

"Production" is the big word in most industrial establishments. However promising a boy might be, the world and his employer will not long be satisfied with promises; he must produce the goods. The shop was called into being to produce needed commodities and it must fulfill its mission efficiently or die. It is not surprising that upon this word has pivoted the whole of business organization, and by this word must be gaged the extent to which each individual fits into the scheme of industrial enterprise. Whatever else the boy may be or do or may not do or be he must produce his expected share of the shop's grist. It is "output" or "put out." The proper balance between quality and quantity is the secret of success in industrial production. A boy may be extremely accurate and painstaking, but be exasperatingly slow. Another boy may be "quick as a wink," but lack the care necessary to proper finish. Each of these will find his niche, but his name should not be "legion," for these niches are limited. The great demand is for those who can co-ordinate carefulness and speed and their number must continue to increase. Both traits can be developed in some degree by training. One naturally expects our schools to teach accuracy rather than speed, but if quick thinking can be stimulated in school work, it will pave the way for the final develôpment of the future skilled producer.

The money question is a serious one to many young people at the age of business opportunity, particularly at this time of national crisis when big wages are available as never before. Too many are willing to sacrifice their futures for immediate financial gain and leave school and further training for what they may now earn. Courses of training in industry are often passed by for futureless jobs with large incomes attached. Thousands of young men are being ruined today by this money-mad policy which has become so prevalent. It is a condition which can be reduced only by the close co-operation of school and parent and employer. It deserves our best thought and effort in a campaign of education which must begin at some point far from the zone of temptation.

We believe that most schools have a direct moral influence which is of the greatest value in steadying the lives of growing youth. Where home and other agencies co-operate with the school in moral training the results are encouraging, but when the school operates alone the task is a trying one. Within the ranks of industry will be found some of the finest people the world has produced, men and women of high ideals and excellent influence. But industry as a whole has not as definite a moral caliber as we might wish; its detailed influence may be for good or for evil; its habit-changing and habit-forming power will some times be for the worse as well as sometimes for the better.

Since the problem of preparation deals with an endless variety of student abilities and tendencies it is evident that individual instruction in school will count effectively to whatever extent it is permissible, for that preparation alone can be effective which takes into account the needs of the individual student. Thoroughness in a smaller number of subjects will outweigh a more pretentious program hurried through. It is not so much the extent of his knowledge as it is his ability to apply what he has studied that measures the value of his training.

OBSERVATIONS by Brigadier-General Samuel McRoberts of the Ordnance Dept., who has just returned from a 2-month's tour in England and France, shows that the Browning machine gun is now being delivered in quantities to the American Forces in France, that it has so successfully met the test imposed upon it that the British and French Governments have asked for any surplus number to be made available to their armies.

The U. S. Model 1917 rifle has the hearty indorsement of our soldiers who have tried it out in battle, and is proving a practical all-around weapon for actual fighting.

General McRoberts states that material taken from the enemy shows no new ideas or striking improvements, but the enemy is using substitute for other metals than steel wherever possible, notably for copper and brass.

As to the morale of the American troops, he said:

"Nothing that has been printed as to the favorable impression made by the American soldier in France has been exaggerated. It is truly remarkable. Not only has he won the admiration of the French people, but likewise that of the French and British officers and men of the British colonial troops. British and French officers constantly remark on the fact that the American soldier seems not only to have enthusiasm but a purposeful confidence and idealism that is inspiring. And his unusual ability to affiliate easily with the people and the allied troops has won for him widespread popularity. More than that, he has demonstrated his capacity as a soldier.

"I crossed going over with a large ship filled to capacity with American soldiers. A British colonel on board who had made many trips on transports carrying soldiers to India, Africa and other British colonies, told me that he had never seen such discipline among troops confined to close quarters as that shown by those American troops. The same observation is made among allied officers in France. Ours is called a 'well-behaved army.'"

YOU MAY NOT be able to fight, but you can save and buy War Savings Stamps.

THOUGHTLESS SPENDING is one of Germany's silent allies.

Reclaiming a Steam Engine

By C. C. Hermann

THE proposition of placing an old engine that has not been on duty for a number of years into service is not an easy task; however, in the present rush it is often economical to take some engine from the scrap heap and place it in service. It is far easier to locate a second hand engine than to entice some builder to fill an order at present because primarily the engine builder is quite busy on rush orders and, secondly, the many factories that have adopted electricity as a means of power, and often purchasing this power from some public utility company have engines that are available. And why not resurrect some of the cast aside equipment? Haven't we been a bit hasty in the past years of plenty and prosperity in sending equipment into the scrap heap? Certainly a little practice of economy in connection with high efficiency can be acquired without material injury to production.

In the salvaging of some old relic, however, one thing must not be overlooked. The engine will not run on its past reputation no matter how good that may have been. To the contrary, it must be thoroughly overhauled and given just as good attention, if not better, than a new engine.

One of the primary requisites of an engine is a foundation. If the foundation is not right, all the following effort will be useless. The foundation should rest on rock if possible or on piles set to rock. The vibration set up by a running engine will soon cause a settling at some point or other, if the foundation is not on rock, which will throw under stress on the bearings and heating results. The writer has had experience with poor foundations as well as good ones and in every case of a poor foundation, more or less trouble has developed. These troubles may be overcome for the time being, but they will crop up time and again before the history of your engine is sealed.

The writer is going to tell his experience in regard to a particular case where an engine was taken from idleness and pressed into service, with the difficulties encountered and how they were overcome.

About a year previous to the time that the writer came on the scene, a 250-hp. Buckeye engine had been taken from the scrap heap and installed in a saw mill to run various saws, jointers and planers by means of a line shaft and counters. The mill was located adjacent to a number of dry kilns which required low pressure steam, that is about 5 lb. steam, to run them. Two 150-hp. boilers had been installed and, of course, it was more economical to use 100 lb. steam in an engine to run the mill than to install motors, since the exhaust was piped to the kilns through a reducer. Thus the steam previously to supplying the kilns gave up considerable work in running the mill.

The engine was of the automatic governor piston valve type and weighed about 15 tons. It had been idle for about 5 yr. and was located about 5 mi. from the site. The job of building the mill, installing the machinery and setting the engine was one of those to-be-completed-yesterday affairs and consequently several contracts were awarded. The contractor that had the setting of the engine and building the foundation was ahead of the building contractor, so that he got the foundation in and the foundation bolts set for the engine before the building contractor got the building walls up. As a consequence, when the engine was set and the building complete the engine did not set square with the building. Furthermore, the contractor failed to carry the foundation down to rock or some substantial footing, so when the engine had run awhile it became badly out of level and alinement, constant heating resulting. One bad feature was that the main line shaft, all the counter shafts and the machines set at an angle with the building, a very bad condition, indeed, and it became the writer's duty to square and level the engine, also to overhaul it completely and to square all the machines and shafts so that the mill could be put into first class operating condition. Of course, this may be an exceptional case, but it does nevertheless emphasize the point

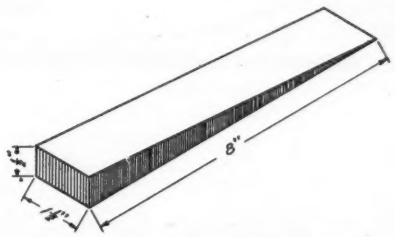


FIG. 1. FORM OF WEDGES USED TO LEVEL ENGINE

that I am trying to make; that is, to use even greater care in setting and placing into operation second-hand equipment than new.

In readjusting matters, the first thing to do was to build an A frame over the main shaft and remove the weight of the flywheel, shaft and crank disk from the bearings. Screw jacks were procured and after the foundation bolts were loosened, the engine was twisted around on its foundation to conform to a line stretched nearby and parallel to the building wall. The cylinder head, piston and crosshead were removed and a center line, consisting of piano wire stretched by fastening one end to a block of wood held to the front end of the cylinder by a stud bolt, the other end of the line being fastened by a bracket on the engine frame back of the main bearing center. The wire was then adjusted so that it was in the same plane as the main bearing center, equidistant between the crosshead guides and, by means of a caliper, in the center of the cylinder. It was an easy matter to adjust the block of wood with a hammer, as the caliper indicated, while the rear end of the line was checked by gaging it with one-half of the length of the crankpin before the main shaft was moved.

To level the engine, a number of iron wedges were made having the dimensions as shown in Fig. 1. These wedges were started between the foundation and the engine base at intervals of 18 in. Another wire was stretched across the front end of the cylinder at right angles to the first wire and adjusted to conform to the center of the cylinder, also the center of

the piston valve cylinder, then made secure by means of a bracket from the engine frame. The wedges were then driven between the engine base and the foundation and the wire levels checked with an engineer's level. The main shaft was then lowered into the bearings and brought to right angles with the center line of the engine by the following method. The crankpin was chalked and then turned so as to touch the wire on one side, making a mark. The flywheel was then turned through 180 deg. so that the crankpin approached the wire on the other side. The outboard bearing was then moved until the mark made by the wire on the crankpin on one side coincided with the line on the other side. The level of the main shaft was tested by a special spirit level and the outboard bearing raised accordingly. This level was checked by hanging a fine plumb line vertically in front of the shaft and the end of the crankpin in con-

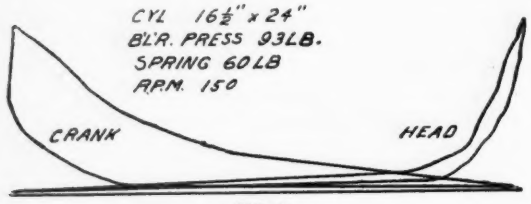


FIG. 2

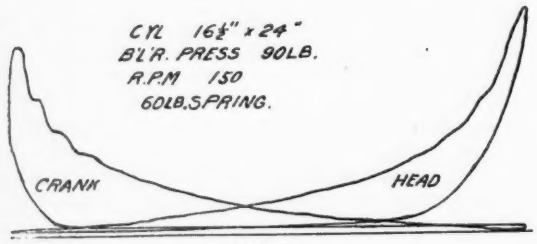


FIG. 3

FIG. 2. INDICATOR CARD TAKEN BEFORE ADJUSTING ENGINE
FIG. 3. INDICATOR CARD TAKEN AFTER ENGINE ADJUSTMENTS HAD BEEN MADE

tact with the line at the uppermost point of its travel. The shaft was then turned half way round and the crankpin end again came in contact with the plumb line. It was not considered profitable in this case to make a new foundation, so a grouting was made of a mixture of wire crete and sal ammoniac, the portions being 10 lb. of wire crete, 2 lb. of sal ammoniac to 88 lb. of water. The foundation was banked up around the edge with mortar and the grouting poured under the engine base. After setting 48 hr., the wedges were knocked out and the foundation finished off with cement.

The engine being level, the next thing to be done was to overhaul it. The flywheel main shaft and crank disk were rolled from the bearings by means of a hoist upon blocking in order that the bearings could be babbited. Two cast-iron journals were made to fit the main and outboard bearings and connected by a shaft. This was done for convenience in handling during babbiting and scraping. The diameter of the main shaft was 8 in. and the length of each bearing 22 in. One hundred lb. of babbit was melted and the bearing body preheated by a charcoal fire being placed upon it. The cast-iron mandrel was put in place, leveled and centered by the center line. The oil chambers were lined with clay and the babbit poured, considerable metal being drained through to heat the surface and carry off the dirt. The drain was then shut off and the bearing poured. The same procedure was carried out in the case of the outboard bearing. The bearings were then scraped nearly to size by the cast-iron journals and then the main shaft was scraped in, after which the caps were babbited and scraped, oil grooves cut and the oil system installed. Very good success was obtained, as evidenced by the service received.

Upon inspection of the piston rod it was found to have crystallized to a considerable extent, a crack having started in the threaded portion where the crosshead screws on. The crack had started at the root of the thread and a knife blade could be inserted to a depth of ⅛ in. or more. A new piston rod was of course made up. I mention this condition of the piston rod because it is well if you contemplate using an old engine that has been idle any length of time to investigate the threaded portions very carefully before and after the engine is placed in operation, because any crystallized condition is serious and often cracks will start at the sharp corners of threads. The crosshead and guides were in fair condition and have given very good service; the piston valve also was in fair condition. The engine stood a good chance to do effective work and since the steam, as before stated, was to be used in the dry kilns nearby, it was not essential that steam economy be at its best as would be necessary under other conditions.

Figure 2 shows an indicator card taken before adjusting and Fig. 3 after adjusting. The leakage no doubt is caused by the piston valve wearing its seat in an oval shape. This comes from the fact that the valve stem works in a horizontal plane, the wear in the steam chest coming on the bottom, allowing the valve to drop away at the top. The cards were taken under the following load: Two 40-in. suction fans, 80 ft. 3 7/16-in. shafting, 60 ft. of 2 7/16-in. shafting and 28 counter shafts of 1 15/16 and 2 7/16 in. diameter. The shafting giving a friction load only. A 60-lb. spring was used, boiler pressure 93 and 90 lb. per square inch respectively, length of stroke 24 in., diameter of cylinder 16.508 in., speed of engine 150 r.p.m. and the reducing motion 8 to 1.

Correction Note

ON PAGE 848 of the Oct. 15, 1918, issue some typographical errors appear which may cause considerable confusion to those not familiar with multiple connection diagrams. The paragraphs explaining the different connections should read as follows:

Single Star

7, 9, 11 = lines.
8, 10 and 12 = star.
1 and 4, 2 and 5, 3 and 6 in series.

Parallel Star

4 and 7 = line
6 and 9 = line.
2 and 11 = line.
1, 3, 5, 8, 10 and 12 = star.

Single Delta

7 and 8 = line.
9 and 10 = line.
11 and 12 = line.
1 and 4, 2 and 5, 3 and 6 in series.

Parallel Delta

4, 5, 7 and 8 = line .
2, 3 11 and 12 = line.
1, 6, 9 and 10 = line.

Power Plants

COMMENTS ON PAPER PREPARED BY OSWALD WANS AND READ BEFORE THE INSTITUTE OF MECHANICAL ENGINEERS

IT WOULD be difficult to find an engineering subject better calculated to set the controversial ball a-rolling than that of the comparative working costs of the principal types of prime movers; and Oswald Wans, in reading his paper on the subject before the Institution of Mechanical Engineers of Great Britain, was no doubt fully prepared for the animated and even contentious discussion that followed. As was only to be expected, faults were found with some of his assumptions, and not a few of figures were challenged by members connected with firms specializing on engines of particular types. Yet the central proposition of his paper—that commercial advantage, not technical superiority, is the ultimate criterion of an engine's worth—was not for a moment in dispute. It is, of course, a truism, but it is none the less worth reasserting from time to time. The right choice of prime mover depends upon the correct balancing of innumerable factors which vary according to time, place, conditions, and particular power requirements. To say that a certain type of engine possesses a high thermal efficiency does not necessarily establish its superiority. That is one factor; it may be overborne by a dozen others. The total working cost of a power plant is compounded of capital charges in the shape of depreciation, insurance and interest, and of running charges in the shape of fuel, lubricating oil, water supply, sundry stores, labor and repairs; and before one can say which is the best type of power plant for a particular purpose, all these factors have to be taken into account.

The object of Mr. Wans' paper was to give data likely to be of service in estimating capital expenditures and working costs, and in establishing the relative commercial value of the principal prime movers. For this purpose he took typical examples of the five types of prime movers—suction-gas engines, and plants burning anthracite, coke and wood refuse; gas engines of the solid injection high-compression type; Diesel engines; and steam engines; and reduced a mass of information, the collection and analysis of which must have entailed great labor, to a series of comparative curves plotted for each item of capital and running expenditure. The conclusions to be drawn from these curves are useful, though fairly commonplace.

Thermal efficiency has its importance, but the overruling factor is the relative prices of fuel in the locality. The advantage of the steam engine rests largely on cheap coal. If the price of coal exceeds on the average 1/5 the price of fuel oil the advantage passes to the solid injection oil engine; if it exceeds ¼ the price of fuel oil, the Diesel engine comes into effective competition. This is for engines of 250 hp. and over; for smaller plants, coal must be relatively cheaper still. Between these extremes stands the suction-gas plant, for which the prices of coal and coke may be respectively 2 and 1½ times the price of coal for steam engines of the larger powers. The use of town gas engines is clearly confined to the few cities in which gas can be obtained at about 26 cents per 1000 cu. ft., and the refuse suction-gas installations to industries in which there is an ample supply of suitable waste material. In relegating thermal efficiency to its proper place in the scale of factors, Mr. Wans passed over one very relevant matter; that the importance of thermal efficiency increases with every rise in the cost of fuels generally, and the value of his paper would have been enhanced if he had added to the excellent series of plotted curves, one illustrating this tendency.

In comparing the rival merits of the leading types of engines Mr. Wans gives prominence to a point which, though it greatly affects capital expenditure, fuel economy, and reliability, often receives far too little consideration—that of over-load capacity. For every engine there is a load at which the engine works at its highest efficiency. That is the rated working load. But it adds greatly to the utility of an engine if it can be made, at a pinch, to carry a considerably higher load. In this respect the steam engine shows an elasticity far greater than any of its competitors, as the following figures for the maximum over-load that can be relied upon with different types of engines show:

Steam engine, 35 per cent above rated working load.

Solid injection oil engine, 15 per cent above rated working load.

Diesel engine, 15 per cent above rated working load.

Gas engine, 10 per cent above rated working load.

The effect of this upon capital expenditure where fluctuating and peak loads have to be reckoned with is apparent. Take the case of an engine required to work at a mean load of 100 b.hp., but to be capable of meeting an occasional demand for 135 hp. In such case, a steam engine of 100 b. hp. rated working load would answer the requirements; but if a gas or oil engine were being installed, a gas engine rated at 123 b.hp. or an oil engine rated at 117 b.hp. would be required to meet the overload demand of 135 b.hp. Thus a larger engine would be needed, and the initial capital cost would be large in proportion. But even more important would be the effect on fuel economy. At the mean load of 100 b.hp. the steam engine would be working at its maximum efficiency, whereas the gas or oil engine would be working under-load, and, consequently, at a reduced efficiency. The following table shows the increase in fuel consumption due to the underloading necessitated by an overload of 35 per cent:

Installation—	Percentage of Mean Working Load Below Rated Working Load	Increase in Consumption Due to Underloading
Steam	Nil	Nil
Oil engine	14.5	2.5
Diesel engine	14.5	2.5
Suction-gas engine	18.5	12.0
Town-gas engine	18.5	8.0

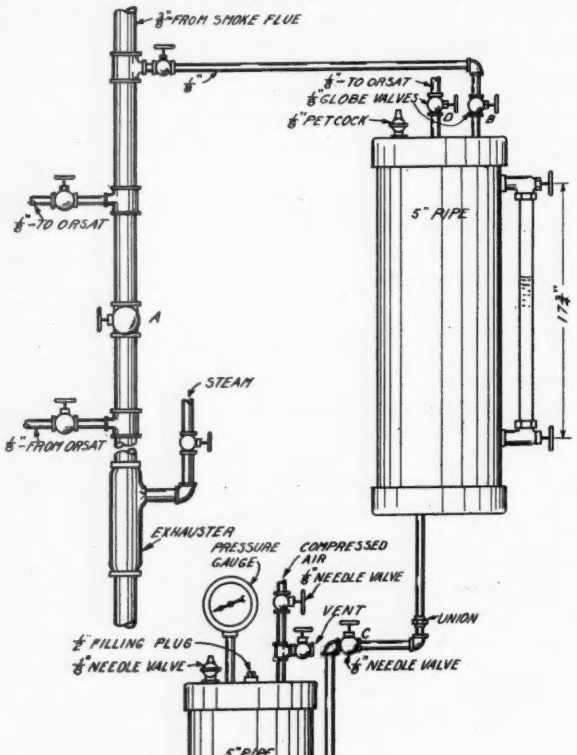
A further allowance must be made for stand-by losses, which will depend upon the frequency and length of the stoppages. The loss, of course, applies only to suction gas and steam installations, and the amount may vary considerably according to the care exercised.

IN WAR TIME every unnecessary purchase is an unwise one.

THRIFT and patriotism are synonymous.

A Continuous Flue Gas Sampler

FOR SEVERAL years we had been analyzing our flue gases with short-period samples, and from results derived were able to make considerable improvement in method of firing and handling the boilers, but always felt that



CONSTRUCTION AND ARRANGEMENT OF FLUE GAS SAMPLER

taking continuous samples over the whole day's run would be an advantage. We therefore constructed the apparatus shown herewith.

Operation of this is as follows: The lower tank being filled with machine oil, steam is turned on the exhauster to free the line running to the furnaces of air when the petcock in the top of the upper tank and the valve on line connecting the 2 tanks are opened and compressed air admitted to the lower tank, which forces the oil into the upper tank. Valve A and air cock on top of upper tank are now closed and the exhauster shut off. We are now ready to take our sample by opening valve B to furnace line, opening air cock in lower tank and valve C to allow the oil to leak back into lower tank at a rate that will almost empty the upper tank in the day's run, the movement of the oil causing a suction on the pipe line to smoke flues, thereby giving an average sample for the day's operation.

To transfer this sample to the Orsat, a rubber tube is connected between the manifold of Orsat and the pipe in the top of upper tank marked "to Orsat." Valve D is now opened and compressed air turned on the lower tank and the flue gas forced into the Orsat, ready for analysis.

The apparatus is neat in appearance, easy to operate and we believe gives fairly accurate results. With 200 hp. horizontal tubular hand-fired boiler we obtain an average of a little over 9 per cent CO_2 covering a month's period. When the boilers are worked heaviest we get the best results.

I would like to hear from other engineers as to what percentage of CO_2 is proper with hand-fired horizontal tubular boilers burning Indiana mine run coal or coals of like quality. J. O. BENEFIEL.

Overcoming Engine Trouble

WHILE WORKING as assistant engineer in a large manufacturing plant, I was assigned to the maintenance and repairs of the engines and elevators. No regular operators, other than the laborers in the plant, were employed to run the cars; obviously, the elevators suffered to a large extent from carelessness and incompetency. The expense saved by this method was offset by a large margin in the shop for labor and material for broken parts of the equipment, although I gained considerable elevator experience at the cost of their mismanagement.

The piston rod on one of the large engines had been a source of annoyance, owing to our inability to keep the packing tight. I was told numerous brands had been used without good results; solid metallic rings were ordered at a cost of $15, but I concluded before using them to make sure the piston was properly centered in the cylinder. However, after removing the cylinder head I was not much surprised to find the piston was down 3/16 in., which was sufficient to ruin the best packing on the market. By properly adjusting the setscrews and calipering from four points on the hub to the counter-

bore, the piston was secured in its proper position, the rod and crosshead was also given proper attention as to its alinement and the new rings were put in place. Needless to say, the trouble ceased.

There also had been trouble with one of the smaller engines running too slow and a larger pulley had been put on the governor, which was of the throttling type. Still this had not proved satisfactory. After being informed of the trouble I decided that the valve had not sufficient opening. The lock nut was loosened on the valve spindle and after a little experiment the proper adjustment was determined, the regular pulley was put back again and proper speed regulation was again maintained. JAMES G. SHERIDAN.

Priming Centrifugal Pumps

THE SKETCHES illustrate the proper and the improper location of priming line connecting priming pump or ejector, for the purpose of removing the air from a centrifugal pump casing and suction line before starting pump.

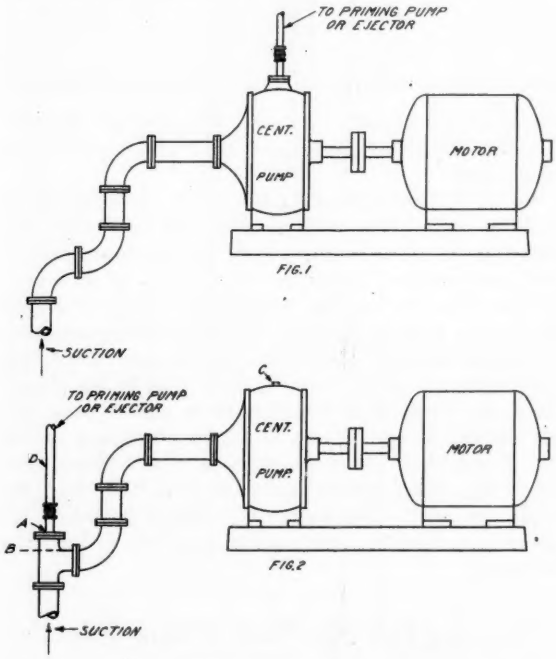


FIG. 1. CORRECT PRIMING PIPE CONNECTION TO CENTRIFUGAL PUMP

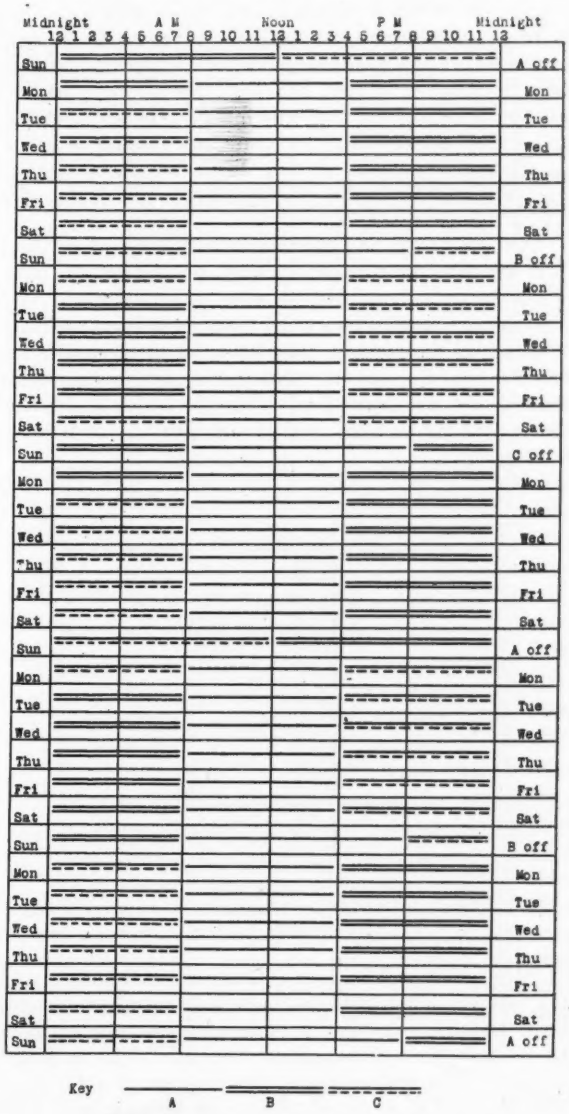
FIG. 2. INCORRECT CONNECTION OF PRIMING PIPE TO PUMP SUCTION

When connection is made as in Fig. 1 all air is removed from suction line and pump casing, allowing the pump to fill completely with water; when connection is made as in Fig. 2 the water will rise past point B, trapping sufficient air to keep the pump from priming readily.

The only time when a priming line connected with the suction at point A, Fig. 2, is practical is when a foot valve is used in the suction line, and water under pressure admitted through pipe D, driving the air out of the line and pump casing through a petcock or valve located at point C. LOUIS P. ALLEN.

Program of Working Hours for Watch Engineers

IN THE following schedule is shown how the three watch engineers' schedule was figured out mutually agreeable to all concerned, which made it possible for all of the three men to get a Sunday off every three weeks; referring to the key below the chart which designates each of the three men A B and C. A does not change watches but B and C change their watch each week. Referring to top of chart, A is off 40 hr. or from 4 p. m. Saturday until 8 a. m. Monday. B changes watches Monday, which gives C 24 hr. off. The following Sunday B is off 48 hr., or from 12 midnight Saturday until 12 midnight Monday. In the meantime, C is changing the watch; that is, after getting through the late watch at 8:00 a. m. Monday he goes to work 4 p. m. Monday and continues this watch for one week at the end of which he gets his Sunday off in the same order as B, then the following Sunday A is off and the proceeding Monday B has 24 hr. off due to C changing



SCHEDULE OF HOURS FOR WATCH ENGINEERS

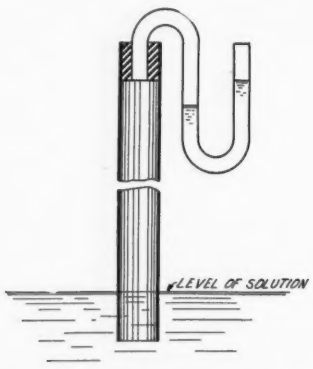
watches then B is on the late watch and gets through 8:00 a. m. the coming Sunday, which is his day off, and comes in 4:00 p. m. Monday on the afternoon watch; therefore, on the second Sunday off for B he gets 32 hr. off instead of 48 hr. as on his previous Sunday off. C is then on the later watch, which also gives him 32 hr. off in the same order as B, after which the watches are again adjusted in the regular order as shown at the beginning of the chart. JAMES G. SHERIDAN.

Handy Liquid Level Indicator

IT IS difficult and inconvenient at times to observe the height of the solution in storage batteries, particularly in those cells that are used for minor purposes usually in sets of six that are installed in automobiles, etc. They are very often so located on account of space that it is very difficult to look down into them without removing them from the compartment in which they are placed.

The writer has had experience with a set of six lead batteries used in connection with a thermostatic indicating device. The batteries with a bank of five 110-v. lamps were installed in a small locker arranged for their reception and the space allotted for the whole equipment was utilized so completely that it was next to impossible to look into the cells at all. The device shown in the sketch was constructed and it has proved very satisfactory.

Take a piece of boiler water column glass about ½

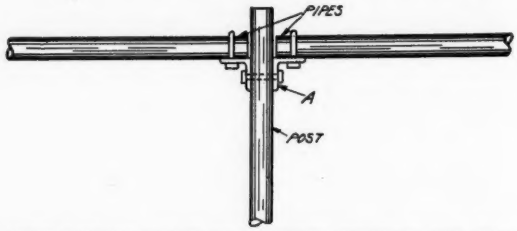


INDICATING LIQUID LEVEL OF SOLUTION BY PNEUMATIC HYDRAULIC DEVICE

in. bore and 4 or 5 in. long. Close one end with a stopper (either cork or rubber), having a central perforation large enough to receive a piece of glass tube of ⅛-in. bore. This piece of tube should be about 6 in. in length and should be bent as shown in the shape of a double U. The inverted U is cut off short (by nicking with a file and breaking off between the fingers), and its end is inserted in the perforation in the stopper. This leaves a straight ½-in. tube open at the bottom. air-tight and connected with a U tube at the top. By submerging the open end of the large tube in any liquid the compression of the air will cause a corresponding change of level to occur in the level of the liquid which is placed in the U tube. The liquid placed in the U tube can be colored to make its movement more clearly perceptible. The effects of compression and displacement will make the actual level of solution in the battery about ¼ in. greater than the observed level in the U tube. This difference can be reduced to practically nothing by giving the parts of the device the proper proportions, but it is unnecessary to do that, as the approximate level is all that is required. T. H. REARDON.

Railing Made Without Screw Fittings

THE METHOD of making railings out of pipe with their respective screw fittings, is a costly as well as time eating proposition; also, when working under difficulties, such as in places where there are live wires, presents a bad game. Having the same proposition on hand, it was de-



CLAMPS TAKING PLACE OF SCREWED FITTINGS FOR RAILINGS

cided to evolve another method. We tried several and at last hit upon this idea which has worked out to our satisfaction.

We used regular floor flanges which were lagged to the floor. The posts were threaded at both ends for flange and cap. The railing proper was cut to the correct length and shipped to the job in bundles of so many. For fastening the railings to the post we use a clamp made by the General Electric Co. This clamp consisted of a body and two U bolts. One bolt fastened the clamp to the upright and the other held the pipe in the clamp. Where two pipes came together on a post we use two bolts instead of one U bolt to fasten the clamp to the post. See sketch. As the men were new to these, they placed the clamp upside down; that is, they had the U bolt reversed. The part "A" should be below the pipe so as to take the compression, while the U bolt take the tension.

Stopping Belt Slip With Cutting Edges*

IN A LITTLE DISCOURSE on belts and pulleys and belt slip, I heard an interesting account a short time ago that I believe is worth chronicling.

A certain belt man who was called "Stubborn" decided that he could stop the slip of a leather belt in his charge by making the pulleys rough. Comrades advised against it, but he headstrongly procured a chisel and nicked the cast-iron pulleys all around so that they were indeed rough. His treatment seemed to have the desired effect for a while, and he completly ignored his fellow workers for a time. He looked on them aloof. In one week, though, the belt that was once a good leather belt was all chewed to pieces. It had to be replaced. The pulleys, also, had to be replaced.

If there is any slip in a belt it is best not to have any cutting edges on the pulleys, and even if there is no slip there is creep, and creep itself would destroy the belt in time. It was declared by the narrator of

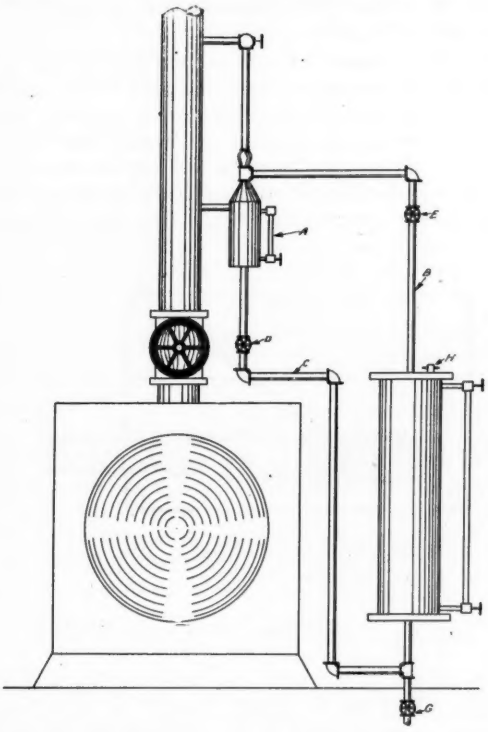
*Copyright, 1918, by W. F. Schaphorst.

the foregoing that by the end of the week the pulleys had already been worn down considerably smoother, and another belt would perhaps have smoothed the pulleys back to their normal condition, but it was decided that the method was too expensive. W. F. SCHAPHORST.

Reservoir for Cylinder Oil

THE ACCOMPANYING sketch shows a lubricator piped to a reservoir, which has given very satisfactory results and has brought about a material saving of oil.

Essentially it consists of a piece of 6-in. pipe 12-in. long capped at each end. Reservoir F is connected to lubricator A by the two ¼-in. pipes B and C. The operation is the same as with the ordinary lubricator; the oil flows from the reservoir to the lubricator through pipe B which is tapped into the top part of lubricator A. As the oil flows from the lubricator, its space is filled by condensed steam, which flows to the reservoir through



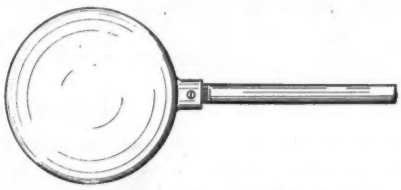
SCHEME OF PIPING EMPLOYED IN CONNECTION WITH OIL RESERVOIR

pipe C. In this manner, lubricator A is always full, thus affording a continuous flow of oil to the cylinder. In order to refill the reservoir, valves E and D are closed, the water is then drained from the reservoir through valve G; oil is then supplied at H which is tapped for a ¾-in. plug. By placing the reservoir close to the cylinder, the oil will be kept warm at all times.

J. A. WISE.

Method of Securing Float to Stem

FLOATS USED in connection with traps receiving tanks, water tanks, heaters, etc., are often the source of considerable trouble. One of the most common troubles on this score is the tendency of the float to unscrew itself from the float stem—usually the float does not fall off the stem but loosens just sufficiently to permit leakage to take place, and then follows unsatisfactory operation because of a sluggish or water-logged float. Although a small and apparently insignificant detail, it is one which can cause considerable trouble and annoyance from time to time. The most effective safeguard is to secure the



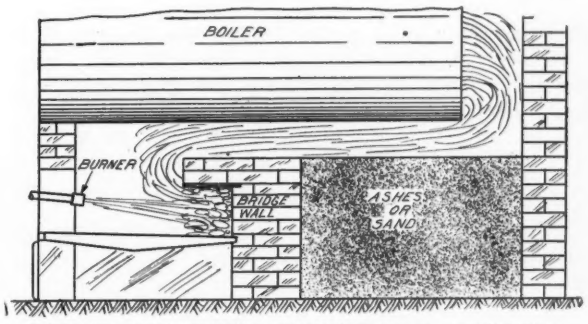
FLOAT STEM SECURED BY SET SCREW

float to the stem in some way and this can be best accomplished by merely tapping into the knob of the float and inserting a set screw to hold the float in place after it has been screwed onto the float stem. M. A. SALLER.

Oil Burning

ON PAGE 723 of the Sept. 1 issue, I find a letter from Reader replying to the recent article on the subject of oil burning by John Pierce.

I should like to inquire whether there is no smoke



FURNACE ARRANGEMENT EMPLOYED BY H. ARMSTRONG

law in Reader's locality, and if so, how he prevents the dense smoke unless he allows air to enter his firebox? If he can operate his furnace without smoke I should very much like to know how he does it.

He further states that one day he burned 32 bbl. of oil and on a following day 25 bbl., load conditions remaining the same. Now, how does he know that the load was the same and how should anybody know this when Reader has failed to state the number of pounds of water evaporated?

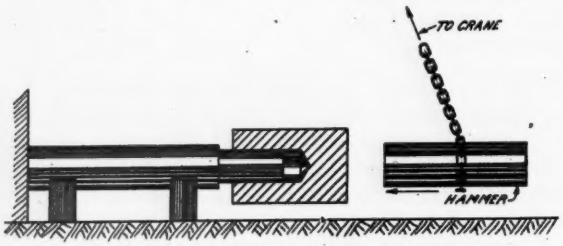
Under some horizontal return tubular boilers which I equipped for oil burning, I employed the arrangement indicated in the accompanying illustration. Except for a space equal to the width of a brick and directly in front of the fire door, the grates were caused to carry a covering of brick which extended to the bridge wall.

The bridge wall was then built with a projection in front so as to direct the flame issuing from the burner against the bridge wall and thereby prevent it from striking directly against the shell of the boiler. This scheme also allowed a more thorough mixture of the gases, thus materially improving combustion.

H. ARMSTRONG.

Using Crane for Heavy Hammering

SOME TIME ago we were compelled to make a driving fit on some extremely heavy work. The idea of using the shop crane for this work suggested itself and with the arrangement shown in the illustration very satis-



METHOD OF USING CRANE FOR HAMMERING

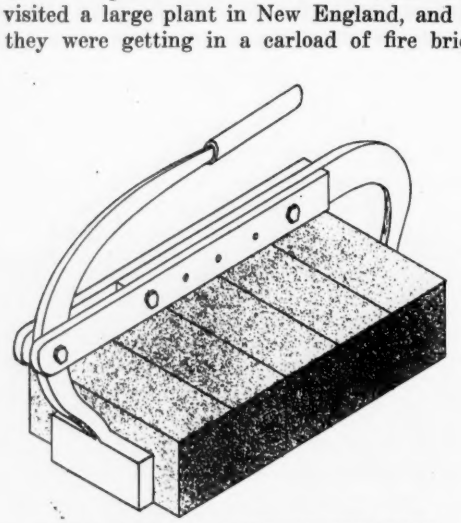
factory results were secured. The hammer, which is very heavy, is held in position by the crane and swinging the hammer back and forth, the men are able to strike hard, true blows without great exertion.

B. A. W.

Fire Brick Carrier

THIS TOOL will be found very handy for handling fire brick without breaking or chipping. It is especially needed where a plant has much fire brick to handle.

I visited a large plant in New England, and at the time they were getting in a carload of fire brick for



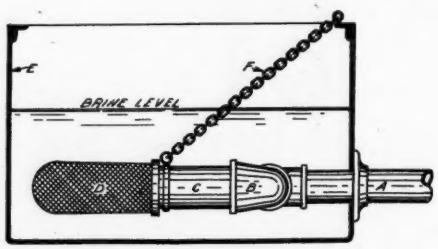
HANDY DEVICE FOR CARRYING FIRE BRICK

store. Perhaps some of the readers may be interested in such a device. The tool was home-made and simple of construction. Considerable time and labor is saved in piling at the store room. C. H. WILLEY.

Convenient Brine Strainer

IN THE illustration is a sketch which may be of some use to readers of Power Plant Engineering. The ice we make for our own use is frozen in the same tank that supplies the brine for our refrigerators and in putting in ice cans, there is always some dirt and wood chips get into the brine, resulting in our brine lines being stopped up quite often, which caused us considerable trouble and annoyance.

We had a strainer on the suction line to the brine pump; but on account of the small area of the strainer and the strong suction of the pump the sediment would be drawn through the strainer and would also stop the flow to the pump. So I made a strainer similar to that shown in the sketch and my troubles have ended. This strainer can be cleaned in 1/6 the time, and I have no



A - SUCTION LINE TO BRINE PUMP
B - SWING JOINT OF PIPE FITTINGS
C - NIPPLE LONG ENOUGH TO LIFT STRAINER OUT OF BRINE FOR CLEANING
D - STRAINER-FINE MESH
E - BRINE TANK
F - CHAIN TO LIFT OUT STRAINER

EASILY CLEANED STRAINER FOR BRINE TANK

nuts or covers to take off. Anybody making a strainer like this should not be afraid to make it large enough, as the bigger the better. H. MASTERMAN.

Some Prctical Kinks

THESE KINKS that I have tried and found successful may interest others.

When filling lubricators with cold oil, always let the oil follow water closely so that no air gets under it. In this way, no time is lost as the oil quickly follows the water.

For cutting a 30 by 34-in. rubber gasket, I drove three nails into a small piece of wood, to make a marker; I then sharpened two with a file and easily cut the gasket.

Some steam leaks were stopped on our boiler by driving Smooth-On iron cement into the leaks when there was a slight vacuum on the boiler. F. B. K.

Cost of Heating a Building

DISCUSSION ON THE APPROXIMATE COST OF HEATING A BUILDING AND THE VARIOUS CONDITIONS TO BE CONSIDERED

VARIOUS formulas have been developed for estimating the cost of heating a building. None, however, has been standardized, for there are various conditions to be considered at different localities which must be modified to meet prevailing conditions. The method here presented is that recommended by the Power Sales Committee of the National Electric Light Association and can be applied with accurate results.

There are two ways by which heat is lost from a building. One is by direct transmission through the walls, windows, roof, etc., and the other is by escape of the heated air contained in the building. The amount of heat transmitted through the walls, windows, etc., of a building, is directly proportional to the difference in temperature existing between the two sides thereof. The amount of this loss through the different materials which are ordinarily used in building construction has been pretty definitely determined and may be expressed in terms of B.t.u. of heat transmitted per hour, per sq. ft. of exposed surface per degree difference in temperature.

The heat loss due to the escape of air is also directly proportional to the temperature difference existing between the inside and outside. For every cubic foot of air at building temperature which passes out, by whatever means, a cubic foot of outside air must come in and this must be raised to the inside temperature.

Where no particular provisions are made for introducing fresh air into the building, natural leakage being depended upon for ventilation, it is usual, in heating calculation, to allow for one complete change of air per hour if the building is of good construction and the windows reasonably tight. For buildings of poor construction this allowance may be as high as two or more, and for buildings of exceptionally good construction it may be as low as one-half. When mechanical ventilation is used, the number of air changes per hour can be figured from the amount of air delivered by the fans.

It requires 0.018 B.t.u. to raise the temperature of one cu. ft. of air one degree so that the volume of building expressed in cu. ft. multiplied by 0.018 gives the heat loss for one degree difference in temperature for one change of air per hour.

The first step in calculation is to determine the area of the exposed walls, windows, roofs, etc. Where there is a variation in materials used or in the thickness, these should be listed separately.

These areas multiplied by the proper constants (see table), together with the heat losses due to air change, will give, when summed up, the number of heat units lost from the building for each degree difference in temperature between the inside and outside.

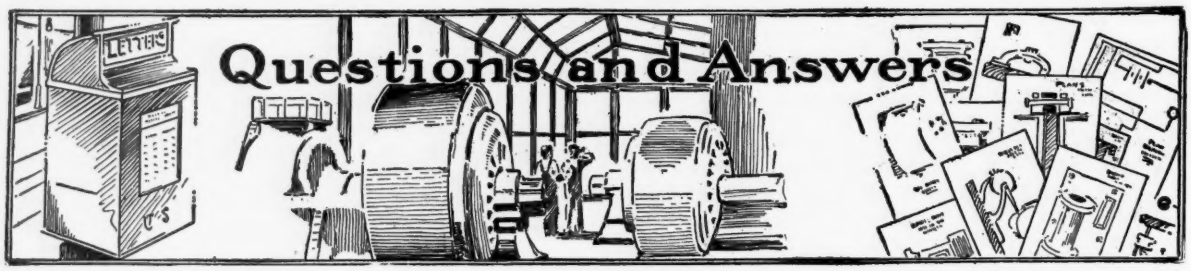
Experience has shown that to the heat losses thus calculated, certain additions must be made as follows:

Add 10 per cent whenever the distance between the floor and ceiling is over 13 ft. Add 20 per cent to the heat loss from the two sides of the building which are exposed to the prevailing winds, usually the north and west walls.

The figure thus obtained for the total heat loss for one degree difference in temperature, may be called the building constant, and in order to determine the amount of heat which must be supplied during the heating season it is merely necessary to multiply this building constant by the number of hours in the heating season and the average difference in temperature between the inside and the outside of the building. This product expressed in heat units may readily be converted to pounds of steam, tons of coal or any other desired unit.

CONSTANTS FOR STEAM HEATING SYSTEM

Walls—	
4 in. brick, no plaster	.55
8 in.	.39
12 in.	.31
16 in.	.25
20 in.	.21
24 in.	.18
28 in.	.16
32 in.	.15
4 in. brick, furring and plaster	.28
8 in.	.24
12 in.	.20
16 in.	.18
20 in.	.16
24 in.	.14
28 in.	.13
32 in.	.12
12 in. sandstone furring and plaster	.28
18 in.	.25
24 in.	.23
30 in.	.21
36 in.	.19
48 in.	.17
2 by 4 clapboards, lath and plaster	.25
2 by 4 clapboards, lath, plaster fillings	.10
Partitions—	
Studs, plaster one side	.49
Studs, plaster both sides	.34
Expanded metal asbestos fill	.21
Fireproof tile, plaster both sides	.30
Solid plaster, 2 in.	.60
Solid plaster, 3 in.	.50
Doors—	
1 in. solid wood	.48
1½ in.	.43
2 in.	.31
Roofs—	
Slate on 1-in. boards	.43
Composition	.30
Reinforced concrete	.43
Sheet iron	1.2
Corrugated iron	1.5
Tiling 1 in. thick	.80
4 in. concrete cinder fill	.60
6 in.	.50
Windows—	
Single window	1.05
Single window wire glass	1.35
Double window	.50
Single skylight	1.10
Double skylight	.60
Floors—	
Cement or tile on ground	.30
Cement or tile, wood over	.10
Dirt floor	.20
Fireproof construction	.10
Cement on brick arch	.20
¾ in., wood-plaster below	.20
¾ in., wood on plaster	.40
¾ in., double wood-plaster below	.10
¾ in., no plaster	.27
Ceilings—	
Fireproof floor above	.15
Fireproof, no floor	.50
Cement or tile floor above	.10
Cement or tile, no floor	.40
Steel floor above	.35
Lath and plaster floor above	.25
Lath and plaster, no floor	.50



Care of Cup Leathers

MY PRESENT WORK is in a beet sugar factory and I would like to obtain some information concerning the care of cup leathers when not in use.

The factory is in operation not to exceed three months of the year. It has been customary in the past to leave the cup leathers in hydraulic operated valves in place until the latter part of summer, when they are removed and placed in water to soak; but it has appeared to me that the cup leather, after once dried out and shrunk, will not return to its original size with soaking. This requires a backing of the original cup with lighter flexible leather which does not last for any great length of time and which means a delay during the operating period to renew the cup leathers.

It is contended by some that if the leathers were immediately removed and placed in water, the leather would rot and not stand the service as well as the present method employed.

If any of the readers of Power Plant Engineering can advise me on this subject, I would be very much obliged. F. P.

Setting Valves After Repair

WITH FURTHER REFERENCE to the question appearing under the above caption on page 855 of the Oct. 15 issue, I would state that there is nothing wrong with the admission of the steam; but if E. A. F. will retard the closing of his exhaust valves, his trouble will be remedied. Apparently the compression is greater than the pressure of the steam; that is particularly true on the head end. On the crank end it is not so bad and a slight change in length of the exhaust rod on the crank end should remedy that. The exhaust rod on the head end is somewhat too long, so that, by shortening this, the trouble can be eliminated.

E. A. F. probably set his steam admission correctly, but forgot his exhaust valves.

E. CAMPBELL.

Induction Motor Winding Problem

I HAVE a Westinghouse textile type induction motor rated at 2 hp., 550 v., 3-phase, 60 cycles, 2.16 amp., 1725 r.p.m., 48 slots which must be rewound, and I would like to learn how to go about the job.

The coils are wound with about a number 18 wire.

Any help you may be able to give me will be greatly appreciated. H. A. C.

A. First count the span of one coil as you take out a whole coil, meaning the number of slots that one coil spans over. For instance, one side of your coil lies in slot No. 1, the other side lies in slot No. 10 or No. 11; counting the slot where the first side of your coil is placed, you go 1-2-3-4-5, etc., until you come to the slot where the other side of this same coil is placed.

In Fig. 1 is shown what is meant by the span or pitch of a coil.

Next count the number of turns in your coil and determine size of wire, whether single or double cotton covered. Alternating current motors are usually wound with double cotton or cotton enamel. Having determined these, you take at least one coil out of your slot and form this coil as near as possible to its normal size as it lies in the slot, or you can measure the lap of the

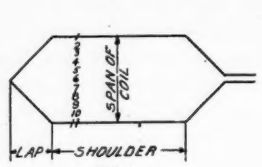


FIG. 1

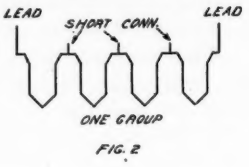


FIG. 2

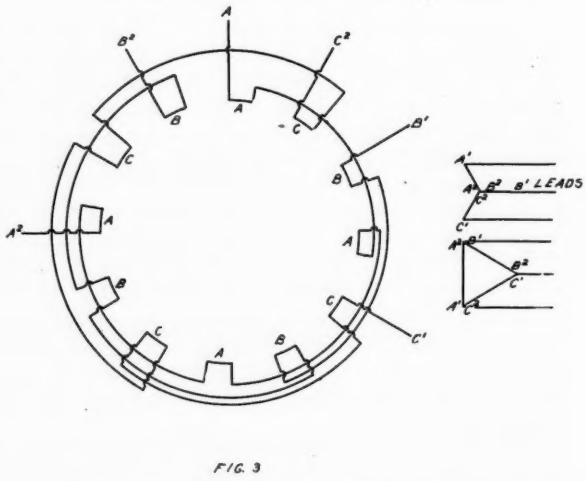


FIG. 3

FIG. 1. ILLUSTRATING MEANING OF SPAN OF COIL
FIG. 2. ILLUSTRATING A GROUP OF COILS
FIG. 3. TYPICAL INDUCTION MOTOR CONNECTION DIAGRAM

coil over the lamination of your motor, the width of the span and the shoulder of the coil; by this is meant the distance of your sides lying in the slot from bend to bend.

This done, you count the number of coils per group or per pole per phase. If you motor runs at 1725 r.p.m. at 60 cycles, you have a 4-pole motor and being a 3-phase motor, you multiply 3 by 4 = 12 and divide the number of coils, which is 48, by 12 = 4 and you get the number of coils per pole per phase.

Next determine the form of connection whether star

or delta. In your case, it is more likely a star connection. This can be ascertained by looking at your leads or jumpers from group to group; if you see 3 wires connected together, it is a star, but if you find on your main leads 2 wires connected to each, it is a delta connection.

Having determined the foregoing, you proceed to strip your motor, taking care not to damage the slots while doing this. If the burnout was caused from the rotor rubbing on the lamination, you no doubt will have some of the iron dragged over, which will close the slots at the places where the rubbing occurred. If this is the case, you will have to straighten the slots, and if any rough places occur they can be smoothed down with a knife blade file, taking care not to short-circuit the iron, which, if short-circuited, will cause heating. Having stripped the motor of all the coils, you must thoroughly clean all the slots and proceed to cut your slot insulation.

The size and amount, you can determine from the old insulation in the slot.

A good practice for 550 v. is to use two pieces of 5-mil. fish paper and one piece of empire cloth of the same size in each slot, placing the empire cloth between the fish papers. In order to make winding easy and speedy, cut your empire and one fish paper just high enough to reach the lower side of the lap on your slot and one fish paper about ¾ or 1 in. higher than the lap on the slots, using this as a guide paper which also protects your coils from damage while sliding them in the slots which would otherwise damage the insulation on the wire if put in next to the bare-iron at the slot opening.

Cut two papers to reach this shoulder only and one to project, placing the two short papers next to the iron in the slot and the guide paper on the inner side of the slot. Now proceed to make a wooden form to wind your coils on; make the form to fit the old coil as near as possible, for if the coils are made too long, you will not be able to put your end shields on the motor; if they are made too short, your motor is likely to heat, due to the decrease in the length of your conductor, at the same voltage. It is good practice to tape the lap on the coils with linen tape; some winders only tape the extreme ends of the coils which form a cushion when the coils are placed in position.

Next place your coils in the motor, and connect each group in straight series which will give you three short connections and at the end and start of the group you will have one lead, meaning two leads to each group. See Fig. 2.

Phase insulation must be placed between groups, to insulate these groups from each other.

When all coils are connected into groups, there will be 24 leads. Proceed to connect each group to its own by skipping two groups and going into the third one, thereby connecting each phase independently, as a 3-phase motor consists of three independent windings. See Fig. 3.

Follow the sketch carefully.

Repairing Leaky Boiler

I HAVE a boiler which leaks at the center seam just above the brick work.

Would it be dangerous to allow this condition to continue for some time?

How would you advise repairing? F. J. H.

A. Usually leakage in the center seam above the bridge wall is due to a deposit of scale at this point. If that is the case, it is dangerous to let it go, as the accumulation of scale is likely to produce overheating, and that is probably what has caused the leaks.

The boiler should be emptied and examined carefully to see whether there is scale deposit at this point. If there is, it must be removed, and the joint examined for any possible cracks. If the metal is in good condition and shows no sign of overheating, the leaks, unless bad, can be taken care of by recalking the seam. If the leaks are bad, it will probably be necessary to cut out the rivets and re-rivet the seam.

Of course, if there are cracks in the plate, it would be necessary to have extensive repairs, as this is not a good place to put a patch.

Elevator Questions

I AM IN CHARGE of five Kansas City and one Crane longitudinal hydraulic freight elevators. These have flyball governors attached under the car, operated by a rope fastened at top and bottom of the shaft and looped around the sheave on the governor. The elevators are about 24 yr. old.

I would like diagrams showing the working parts of the valve.

How would you determine ratio of plunger travel to car travel?

Can you provide me with a suitable method for centering up?

Can the speed of the elevator be increased without raising the pressure? L. R. G.

A. It is impossible for us to furnish diagrams of the working parts of an elevator installed 24 yr. ago.

You speak of Kansas City elevators. We find that H N. Strait & Co., of Kansas City, Kans., makes freight elevators, also the Abell Elevator Co., 209 Oak St., Kansas City, Mo. We presume that the five elevators referred to are made by one or the other of these firms; very likely, H. N. Strait & Co.

In regard to the Crane elevator, we do not find anyone manufacturing an elevator by that name, at the present time. We presume it is of an old type, made by the Crane Co. There would, however, be no possible way of getting a diagram of the working parts of the valve, except from the old files of the manufacturers, as there were practically no books on elevators in existence at the time these were built, and no articles had been written on the subject of elevator details.

The governor that you speak of is probably one of the regular safety, overspeed governors. Sometimes these are put under the car, and sometimes over the car, and if the speed of the car gets too high, the balls of the governor fly out to a point where they trip a catch, which, in the case of an elevator with wooden guides, allows a dog on each elevator to dig into the guide and stop the car; or, in the case of iron guides, allows friction clamps to take hold and exert sufficient pressure on the guides to stop the car. This is an overspeed governor, and is purely for emergency service.

I judge you have the hydraulic, horizontal cylinder with ropes passing over a series of drums to the top of

the car; one fixed and one movable set of sheaves. If there were just one set of wheels, it is evident that in moving one foot it would be necessary for 2 ft. of rope to wind around the pulleys. If there are two sets of wheels, then one foot movement of the cylinder will take up 4 ft. of the vertical rope. If there are three sets of wheels, it will take up 6 ft., and so on.

I do not quite know what you mean by the "method of centering up," as it is not a term commonly used in regard to elevator practice.

The speed of the elevator cannot be increased under full load without increasing the pressure. Of course, for light loads, the speed can be increased by opening the valve, except that there is usually a speed governor which will prevent the speed going beyond a certain point, unless the adjustment of the speed governor is changed.

We believe your best way to get at the information that you want would be to take up the question direct with the makers of your elevator in Kansas City, either the H. N. Strait Co. or the Abell Elevator Co., as they would have the fullest information in hand.

Reducing Boiler Horsepower

WE HAVE an 80-hp. boiler that has been used for furnishing steam for a 35-hp. engine and for laundry machines and dry rooms. However, we have installed motor drive for all machinery, and only use the steam for heating the laundry machines and washers. I believe that a 50-hp. boiler would more than meet our requirements. Do you think that by reducing the grate area by bricking up side walls and bridge walls from 5 to 3½ ft., it will cut down the horsepower as well as coal consumption? W. H. R.

A. There is no question but that you can reduce the horsepower of your boiler and the coal consumption by bricking up the side walls and bridge walls so as to reduce the grate area. You will want to be sure, of course, that your boiler setting is tight, as with the reduced grate area there will be a much greater tendency for air to leak into the setting and around clean-out doors and similar openings, and this will cut down efficiency.

The cutting down of the grate should all be done at the sides, not reducing the length at all, as this would tend to hurt your conditions for good combustion, particularly with the coal that we are getting these days.

Foaming and Priming of Steam Boilers

WHAT ARE the causes of, effects due to and remedies for (a) foaming and (b) priming of steam boilers? M. J. C.

A. Priming is the passing off of steam in beleches which carry over water; it is caused by the concentration of such substances as sodium carbonate, sodium sulphate, or sodium chloride in solution. Sodium sulphate occurs in many southern waters, and is also found where calcium or magnesium sulphate is precipitated with soda ash. The degree of concentration which may occur before priming will commence, varies widely with the conditions of operation and may be definitely determined only by experience with individual cases.

Foaming, the effect of which is similar to that of priming, is likely to occur in water contaminated with sewage or organic growths, due to the fact that the suspended particles collect on the surface of the water in the boiler and render difficult the liberation of the steam bubbles arising to that surface. It is sometimes due to the light flocculent precipitates from carbonates in solution, and in certain cases where any animal or vegetable oil is present, it is due to the fact that there is an excess of sodium carbonate added to the water during treatment.

Where foaming is caused by organic matter in suspension, it may be largely overcome by filtration. Such matter as is not left in the filter may usually be taken care of by surface blowing. In some instances, settling tanks are used to overcome this difficulty; but where large quantities of water must be provided, filtration is used as a substitute for the time and area necessary in settling tanks. When caused by over-treatment of feed water, such treatment should, of course, be changed.

Where priming is caused by excessive concentration, it may be overcome largely by frequent blowing down of the boilers. Where the salts in the boiler feed exist in such quantities that to blow down sufficiently to keep the concentration below the priming point is not feasible, because of the resultant losses, it may be overcome by some process of feed treatment.

Wire Sizes for Power Service

I WOULD LIKE to know the size of wire required to serve two 20-hp. and two 15-hp. 230-v. direct-current continuous duty interpile motors with a speed range of from 600 to 1200 r.p.m.

What size would be required for all four motors? T. M.

A. The method we use for determining the size of wire necessary for connecting up electric motors is by the use of tables which are found in electrical or mechanical engineers' handbooks. From these we find that a 15-hp. motor will require a No. 6 weatherproof, or a No. 5 rubber-covered wire; a 20-hp. motor requires a No. 5 weatherproof, or a No. 3 rubber-covered wire, while the wire necessary to carry current for all four motors must be a No. 000 weatherproof, or a 300,000-circular mil rubber-covered cable.

Inasmuch as you do not state the distance the current must be transmitted, we do not take into consideration the drop in voltage along the line.

Estimating Charges for Steam

WE HAVE a dye plant near us wanting us to furnish them steam, they to make all connections to our boilers, and we to furnish boilers, water, firemen and coal.

They are also to furnish a $255 steam meter. At what price can we furnish them steam and make a good profit? R. H. B.

A. It is difficult to make an estimate of what price you should charge for furnishing steam, without a knowledge of the cost of fuel, the wages that you are paying, and the cost of installation of your plant. The only thing we can do is to give you a general idea of prices and costs in other plants.

United States Geological Survey, in its investigations, has found that the price for furnishing steam in central

station heating plants runs from 50 to 60 cents per thousand pounds. This is where the central station installs and keeps up the distributing system and supplies the steam to the customers' premises.

In the making of a thousand pounds of steam, you will, of course, use 1000 lb. of water, and probably about 200 lb. of coal. You will, therefore, have to figure these costs in your plant, and, in addition to that, figure the cost for coal handling and firing, which will vary from 10 cents a ton where the coal has to be handled by hand a distance of 5 yd. or less, to 20 cents a ton where the distance is 10 to 20 yd. Of course, if your boilers are stoker-fired, this will reduce the cost of the coal handling.

Gebhardt estimates that the cost for making steam is from 40 to 60 cents per thousand pounds, depending on the size of the plant, cost of fuel, and the rate of wages. It is fair to presume that, with these figures as a basis, and considering the rise in price of coal and of labor, you would need to get at least $1 a thousand pounds to give you a profit on this proposition.

This, as you will realize, is an estimate and should not be relied on too greatly.

Engine Questions and Answers

How many expansions of steam are there in a compound engine? 2. How do we find the area of the section of a boiler head over the tubes? 3. How can the valve of an engine be lengthened without changing the throw of the eccentric? W. H. C.

Answers

The total expansions in a steam engine of compound type is found by multiplying the number of expansions in the high-pressure cylinder by the ratio of cylinder volumes. Neglecting clearance—if you have cutoff at ¼ stroke in the high-pressure cylinder, there will be four expansions in that cylinder; and if the ratio of cylinder volumes is 3, the total expansions would be 4 times 3 or 12.

2. The formula for finding the area of the segment of a circle is as given below:

$$\frac{4H^2}{3}\sqrt{\frac{2R}{H}} - 0.608$$

Where H is the distance from the chord of the circle to the outside, and R is the radius of the circle. In the case of a boiler head, the area to be stayed above the tubes is found by the same formula, only that the value of H is taken as the height of the segment less 5 in., and the radius is taken as the radius of the shell less 3 in.

3. We do not quite understand your question. The only way to lengthen the valve of an engine is, of course, to add blocks to the end of the valve, which can be done by riveting on or screwing on pieces of iron and finishing the surface flush with the surface of the valve. If you mean how can the valve travel be lengthened without changing the throw, this can be done by the use of a rocker arm interposed between the eccentric rod and the valve rod.

Make-up Required for Condensing System

Will you kindly inform me as to the percentage of make-up water required in a condensing engine plant equipped with (a) a cooling tower and one provided with (b) a spray pond? J. O. B.

A. In regard to the make-up water needed for a condensing system, that used for the boiler feed depends, of course, on how much exhaust steam is used for other purposes than to send to the cooling tower. Ordinarily, 4 to 5 per cent will be all that will have to be added to the condensed steam.

For the cooling water which is used in the towers or in the spray pond, the loss will vary from 3 up to 10 per cent, according to conditions of cooling. The more loss there is, the greater will be the reduction in temperature of the cooling water, and the more effective its action in the condensers.

For your conditions, we should judge that the loss will be 4 to 5 per cent with cooling towers, in the summer. In winter, it will be much less.

With spray ponds, it is estimated that the drift of water from the sprays, by reason of wind blowing, will amount to some 2 per cent, and the loss from evaporation to about the same amount. There will not be much difference in the total loss between the cooling tower and the spray pond.

Economy of Fuel Oil

How does the economy of fuel oil compare with that of coal? W. S. H.

A. So far as the economy of oil burning is concerned, at present prices there is none. At a recent meeting of the Society of Mechanical Engineers, it was stated by an expert on the subject that the price of coal would have to be about $28 a ton in order to make oil available, from an economical standpoint, as a boiler fuel, at the present price of fuel oil. Where oil is in use, it is largely a matter of being willing to pay the extra cost for the sake of greater cleanliness, or because the fuel oil supply is more certain.

Practically the only oil now available is that with an asphaltum base from Mexico, and the Mexican Petroleum Co. is not in position to accept additional orders.

In order to put coal and oil on an equality in economy, taking into account the lessened labor expense and the cleanliness, it has been estimated that the cost per pound for oil can rise to 60 per cent higher than the cost per pound for coal. The efficiency of oil burning is somewhat greater than that of the coal furnace, the labor of handling is less, and there is no cost for removing ashes; but there must be a rather expensive storage system for the oil and a system for warming and pumping the oil, which is comparable in its cost to that of mechanical stokers for coal.

Cushioning Air Disappears

Our pump doesn't seem to get air enough to keep it from pounding except when air is pumped into the chamber from an outside source frequently. I am appealing to readers for a suggestion that will help me out of this difficulty. The pump is a compound duplex center packed plunger type 12 and 18 by 8½ by 12 in. made by the Epping-Carpenter Co. The air chamber on the discharge is 12 in. diameter by 6 ft. high, the suction chamber is 12 in. by 2 ft. J. E. M.

POWER PLANT ENGINEERING

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Keeping at Routine Duties

The work of the operating engineer is so inconspicuous in the public eye that the consciousness of duty performed must often, perhaps generally, be its most enduring reward. In time of war the fighting man receives merited recognition while the man whose punctuality, mechanical ability, training and experience, makes it possible for the former to have at hand the necessary tools and supplies for successful battle is taken by the public as a matter of course. Now and then, when a ship goes down in battle or when through forced speed the enemy is successfully overhauled and sent to his well-deserved doom, the brave fellows in the fireroom and the turbine room are given a few lines of appreciation; but in the main, these self-effacing chaps of the shovel and the throttle work behind the scenes both at home and abroad.

All through the engineering profession it is known that the operating engineers stand second to none in patriotism. The fact that so many of the older men are willingly taking on tasks and burdens hitherto carried by younger subordinates speaks volumes for their devotion to the industrial side of the war. The story of what operating engineers have done to keep up to Uncle Sam's demands on their plants for munitions and supplies of every kind will make interesting reading in years to come. It will show a disregard of physical limitations which will always redound to the honor of these men behind the front, and an enthusiasm in meeting difficulties and conquering them in the face of unprecedented delays in the supply of equipment and material, prices extraordinary and a labor shortage of appalling dimensions. For the present, the engineer is saying little about himself, but he can take a lot of satisfaction in the dividends which are coming home to him in the way of victories on the other side of the Atlantic, and may well think upon the solidarity of the technical brotherhood of these history-making times.

It is most important at this time, however, not to misinterpret these victories, and not to ease off in either the quality or the quantity of one's work in the belief that the end of the war is close at hand. The strain of present-day burdens is indeed great upon many operating men, but this is not the time to reduce load on the theory that the Kaiser will shortly sue for peace on bended knees. There is no more dangerous prediction than the date on which the war will close. It cannot be too often emphasized that the duty of every one of us is to act as if the Huns were pressing the Allies backward and were rousing every possible determination to win the victory against them; that we must work and fight as if the outcome were dependent upon the efforts of every single one of us, and indeed that is the case. Victory *may* come, complete and lasting, within a fortnight of the day on which these lines are read, but to act upon such an assumption by slackening efforts, by letting routine duties sag off a bit, by stopping to look backward at what has been accomplished, is taking risks of a very perilous kind! We can afford to let Marshal Foch and his men fix the day of reckoning which is coming just as surely as Right is Might! Let us all stick to our jobs, however, and endure the privations and

fatigues of war time with sustaining courage, untiring loyal service and determination to see this thing through to a just and lasting peace based upon the destruction of Prussian militarism, cost what it may!

Curbing Auxiliary Waste

Necessity has compelled us, as a nation, to give the matter of fuel conservation more consideration than it has ever before received, and it is to be hoped that, with the cessation of hostilities, we will neither be allowed or allow ourselves to drift back into the wasteful and extravagant practices of pre-war days. The available supply of fuel is limited and in order fully to conserve that which we have it behooves every one of us, and especially those responsible for the conversion of fuel from the thermal to the dynamic form of energy, to seek and adopt ways and means to reduce to a minimum all avoidable losses.

Improvements in the design of power plants and their component parts tending toward greater economies and higher degree of efficiencies have wrought results almost phenomenal, yet much remains to be done. Unless local conditions necessitate the contrary, no designer, constructor or operator would countenance the use of non-condensing units discharging volumes of steam into the atmosphere. Instead, every bit of heat should be utilized, and as a consequence the resulting losses are limited only by the combined efficiency of the various pieces of apparatus making up the whole.

Citing the average power station, this cannot, however, be said of the entire installation. Investigation of the auxiliary equipment will prove otherwise. Generally, with some exceptions, of course, the units driving the various pieces of auxiliary equipment are operated non-condensing, the steam exhausted being utilized to a greater or less—generally lesser—degree in the heating of the water supplied to the boilers.

How many of the installations thus arranged are able to operate on a truly economical basis? Very few, as is evident by the great volumes of steam which belch forth from the exhaust heads above the average plants.

Greater attention must be given the auxiliary equipment. Electric drive may be employed, but this only to a limited extent, as some steam must be available for the heating of the feed water. It would, therefore, appear desirable and advisable to equip all the various pieces of auxiliary apparatus, such as the exciters, boiler feed pumps, condenser pumps, fans, etc., with both electric and steam drive, employing the latter only at such times as an actual demand for exhaust steam may exist. In fact, automatic control may be advantageously employed, thermostats placed within the heaters governing the flow of steam to the units according to the temperature of the water. With temperatures comparatively low, perhaps all or at least a great portion of the auxiliary steam-operated units might be utilized, while with the temperature high, electric drive could be employed with the steam-operated units running idle or partially loaded.

The first cost of such an arrangement would undoubtedly exceed that involved with present-day practice, but that this will many times be offset by the resulting gains is without question.

Official Facts

By Harvey O'Higgins

LEMON DROPS. These are a small thing in themselves, but look at the way the War Department handles them.

In our first draft armies it was found that they were a favorite candy with the men; also that most of the commercial lemon drops were made of glucose, flavored with an acid imitation of lemon juice.

So the military authorities got samples from all the candy makers, analyzed them, chose the best, got the formula for its manufacture and placed orders for a supply according to that recipe.

Now our boys are supplied with lemon drops made of pure granulated sugar and flavored with an extract from lemon peel, which have the thirst-quenching qualities of good lemonade; and they use 200,000 lb. a month.

Soluble coffee, another little thing; but it's mighty handy for the men in the trenches or front line camps. So experiments were made to get a good quality of coffee in stick form like chewing gum, in waterproof wrappers and easily dissolved in cold water, so that the soldier in an exposed situation can have a cup of coffee without attracting the attention of the enemy. The supply is not equal to the demand, and new companies are being formed for its manufacture.

A new shoe with three heavy outer soles and a superior quality of upper leather is being issued to the men to replace those which are used up at the rate of 3,000,000 pairs a month. This has necessitated restriction of the sale of sole leather for civilian use.

And safety razors are being issued to the men for the first time in history, so that they can keep clean shaven under the most adverse conditions.

So, if you find it impossible to buy soluble coffee, thick soled shoes or your special brand of safety razor blades, and are asked to cut down on your use of sugar, it is because the boys in the army need them.

Fighting the "Flu"

AS a suggestion of effective methods in checking this menacing disease, the plan adopted by S. F. Bowser & Co. may well be studied. Stations have been installed about the different buildings, and every employe is requested to have his or her throat and nose sprayed twice daily. The service is free by specially instructed attendants.

Special bulletins are posted as to this service, the sending home of anyone afflicted with coughing, sneezing or running nose and the duties of Deputy Health officers, who are appointed to enforce the rules and laws of the city health department. All cases showing the slightest symptoms must be reported to the deputies and sent home, to remain until the symptoms have disappeared.

All spittoons have been removed as being one of the common mediums of transmitting the disease.

Employes realize that everything possible is being done to safeguard their health, and are responding willingly to the treatments and precautions taken by the Company for their benefit.

Soft Flexible Metallic Packing for Condenser

AFTER several years' actual use, "John Crane" Soft Flexible Metallic Packing is recommended by The Crane Packing Co., 9 South Clinton street, Chicago, for use in condensers. The advantages claimed of this packing in condensers are that it is permanent, fills every crevice so completely that leakage is impossible, saves labor, and in the end is by far the most economical packing. Since the efficiency of steam turbines and condensing engines is dependent upon high vacuum, and since 12,000-tube condensers are not unusual these days, it is evident that the 24,000-tube packings in such condensers must be as good as human ingenuity can make them. They must prevent leaks dependably and permanently.

This packing is made of thin babbit sheets, wrapped round and round spirally, lubricated between every layer and die-formed into rings, as shown in Fig. 1. This

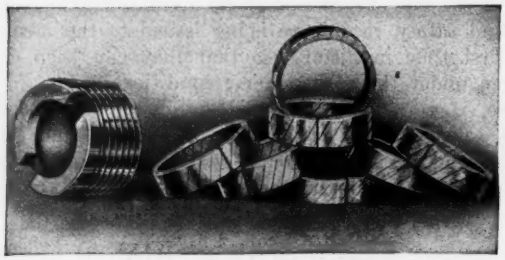

FIG. 1. RINGS OF JOHN CRANE METALLIC PACKING

produces a ring of exact size and removes all guess work as to uniformity. The simplicity of installation is apparent. This pliable, metallic material under pressure of the gland completely seals the tube, yet allows freedom for the tube to slide. There is no expansion or contraction. No excessive binding. A tube can be removed without disturbing the packing, and the same packing may be used for sealing a new tube. Also, the packing centralizes the tube. To insure further against leaks two or three rings, with joints staggered, are usually placed in each stuffing box.

This packing has another important advantage in being all-metallic, in resisting alkali, acids, salts, and such chemicals in solution. It is well known that pure circulating water is seldom found in central stations, water works plants, large industrial plants, etc. In marine service the salt circulating water through condensers ruins many kinds of packing in a very short time and it is well known that when sea water gets into the steam space of a condenser it is a serious thing. The chemicals and other foreign matter in sea water have been a source of great annoyance on board ship.

Figure 2 shows how "John Crane" packing is put in place in the stuffing box. It is evident on examination of this illustration that much time is saved in packing the tubes because it is merely necessary to put in the ready made ring and screw in the gland, as indicated. Fitting, trying, removing portions, cutting off, etc., are eliminated.

This packing is equally valuable on evaporators and heaters, and is now being used for packing practically everything in power plants and on ships from valve stems to the largest plungers and on service ranging from plain pure water to concentrated acids.

No matter how efficient any vacuum pump may be, it cannot maintain a high vacuum if the engineer in charge is careless about air leaks. Two places that are

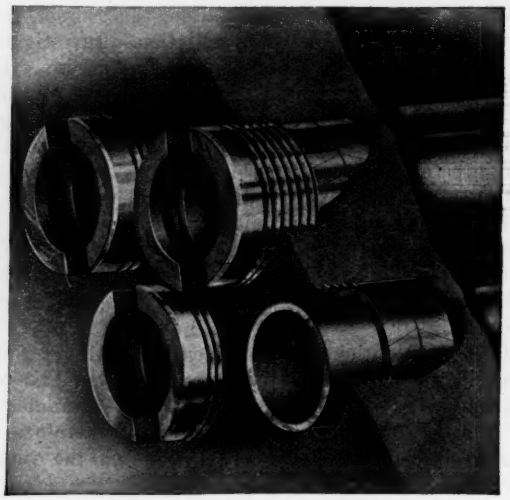

FIG. 2. JOHN CRANE METALLIC PACKING APPLIED TO CONDENSER TUBES

frequently overlooked in sealing leaks are the low pressure cylinder valve and piston rod stuffing boxes. The pressure around these boxes, remember, is toward the inside and not toward the outside. One can detect leaks through these stuffing boxes by holding a flaming torch close to them and noting whether or not the flame is sucked in. To make a good torch simply dip a pine stick in alcohol and ignite.

This torch method can also be applied in finding leaks around steam pipe joints leading to the condenser or around the condenser tubes themselves. The condenser must be under vacuum, of course, when the test is made.

Where a steam turbine is used instead of a reciprocating engine, the flame method is similarly applicable to finding leaks at the low pressure end.

Quick Repair of a Cracked Intercooler

THE intercooler on a 12 by 22-in. twin steam, two-stage air compressor developed a crack ⅛ in. wide running for 5 ft. between the end of one of the bracing ribs to the diagonally opposite end of the other rib.

To have dismantled the intercooler for repairs would have been exceedingly expensive and would have necessitated putting the compressor out of service for several days at least. Before going to this expense, it was decided to attempt to repair the crack without dismantling by using Smooth-On Iron Cement. The two ribs were first drilled, as shown, to receive 12 ½-in. bolts. The crack was then cleaned, and while this was being done a quantity of Smooth-On Iron Cement No. 1 sufficient to fill the crack was mixed with water to a smooth putty-like consistency.

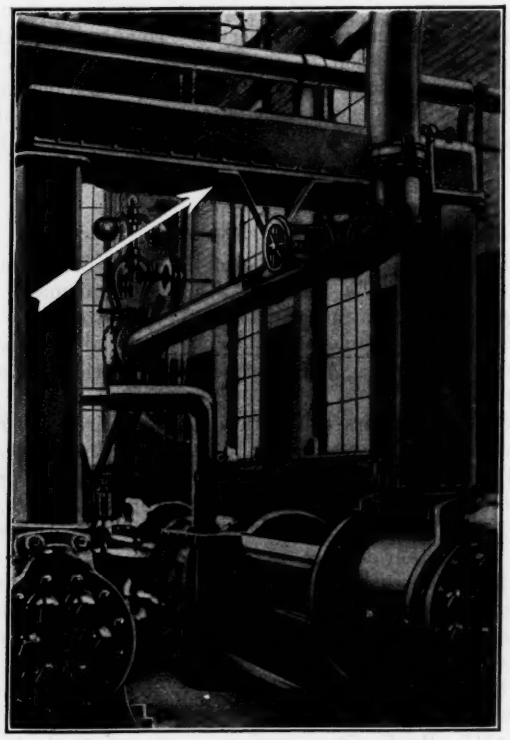

FIG. 1. GENERAL VIEW OF INTERCOOLER REPAIRED WITH SMOOTH-ON CEMENT

The cement was then applied to the crack and thoroughly caulked. While applying the cement, the exhaust port of the low-pressure cylinder was closed and the high-pressure side turned over at slow speed so that a partial vacuum was maintained in the intercooler. This drew the cement well into the crack. After smoothing down the surface of the cement the 12 bolts were inserted and drawn taut. The Smooth-On Iron Cement, expanding as it metallized, completely filled the crack and became practically integral with the original metal. The whole repair was accomplished in less than 3 hr. and the compressor was ready for service on the following day after the cement had thoroughly metallized. No sign of leakage developed on starting up, and the repair has now been in service for some time with every indication that it will be permanent.

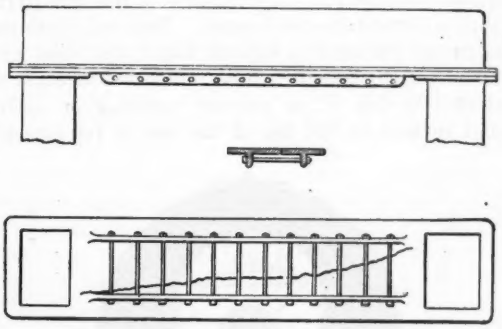

FIG. 2. INTERCOOLER SHOWING LOCATION OF CRACK AND SCHEME OF BOLTING EMPLOYED

Defender Combination Boiler Room Instruments

IN the operation of boilers, two of the most variable conditions, and at the same time conditions which affect most seriously the efficiency of the boiler and furnace, are the draft and flue gas temperature. With these facts in mind, the Defender Automatic Regulator Co., of St. Louis, Mo., has devised convenient draft gages and thermometers for the purpose of indicating these conditions. These instruments have been arranged in a dust and water proof case for mounting on the front of the boiler or any other location most convenient for the fireman in charge.

Two combinations of these instruments are illustrated herewith. Figure 1 shows the arrangement highly recommended for use in plants where natural draft is employed to supply air to the furnaces. This consists of a duplex draft gage connected up with the boiler setting so as to indicate the loss in draft through the fuel bed and through the gas passages of the boiler

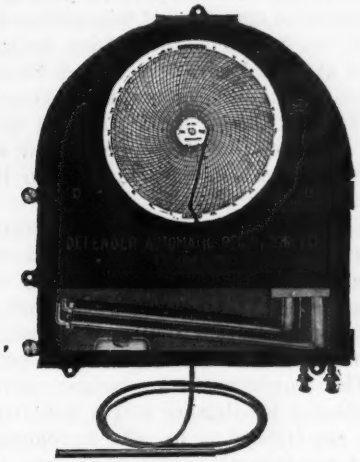

FIG. 1. DEFENDER GAGE CASE FOR NATURAL DRAFT

separately, and in the upper part of the case is a recording flue gas thermometer.

In Fig. 2 is shown the combination designed for use in forced draft plants. It consists of a flue gas pyrometer and a three-tube draft gage. Both of these combinations are inclosed in similar water and dust proof cases made of stove iron castings, enameled in black and baked at 800 deg. F. to prevent cracking or peeling. The flat surface on the top of the case is for attaching

FIG. 2. DEFENDER INSTRUMENT COMBINATION FOR FORCED DRAFT PLANTS

the electric light bracket. Heavy plate glass is used in the front and is cemented in with water and temperature proof cement. The case is adaptable to other combinations of instruments.

Coast Artillery School

FIRST, any man who hopes to be an officer in the U. S. Army must be ready to subject himself to discipline and work his hardest cheerfully. The enemy "shoots well." The artillery officer must also learn to shoot well.

The Heavy Coast Artillery is furnishing and will furnish regiments to man guns of 6-in. caliber and above, and to supply the needed officers, a 3-mo. training course is established at Fort Monroe, Va. Each Saturday, 200 men are taken into the school, and upon successful completion of the work those passing the tests will be commissioned. Of course, no man entering the school can be guaranteed a commission. He is given the opportunity and it's "up to him."

While waiting to enter the school, a man is given military training and some instruction in elementary mathematics, including plane trigonometry and logarithms. The regular course covers materials, gunnery, gas defense, administration, drill and calisthenics.

Engineering education is not necessary, but is an advantage. The requirements are proper spirit, mental attitude, ordinary intelligence and a hard day's work. The officers are trained to be able to command troops and to make hits with their batteries.

Those in charge have been on the western front and know what should be taught. Instructors come back each month from the American Expeditionary Forces so as to keep the work up to the standard demanded by General Pershing. Plenty of equipment is available for the work, also a land target range at Camp Eustis on the James River for practical instruction in firing.

The school will consider applications from citizens registered for military service, but does not agree to accept every application. For enlistment and preliminary instruction the country is divided into five districts, North, Middle and South Atlantic, North and South Pacific, and in each district one or more forts are selected, where men will be grouped for a 6-weeks course. This will include school of the soldier, and preparatory mathematics. At its close, examination will be held, and those completing it successfully will be sent to Fort Monroe. This preliminary work is not compulsory, and any man who feels that he does not need it can take the examination immediately. Those who feel the need of a short review, can take two weeks of military instruction and mathematics at Fort Monroe in what is known as the "reservoir" company, and then take the examination.

Communications should be addressed to Commandant, Coast Artillery School, Attention of Communication Officer, Fort Monroe, Va., for further details and application blanks.

News Notes

DIRECTOR OF ENGINEERING of the U. S. Employment Service, 29 So. La Salle St., Chicago, announces the following technical men available for war work.

2418—Gas engineer and chemist; special experience in charge of testing of coal, coke, oil, gas, brick, fire clay and tar.

3874—Chief draftsman and office organizer, designer of structures of wood, concrete and steel; investigations and research; graduate of Brown University; post-graduate courses of Harvard School of Applied Science.

1244—Mechanical draftsman, experience with internal combustion engines, pumps and boilers.

2194—Designer and chief draftsman in charge of design and construction of machinery and buildings; specializes in design of structural steel, tanks, shop machinery, concrete, wood, cranes and plate work.

322—Graduate chemist, analytical and general chemistry.

4512—Production engineer; superintendent of plants; manufacture of small and interchangeable parts, such as artillery fuses, tool and master gages, also a tool and die maker.

2202—Electrical engineer; research work; development of electrical and small machinery; manufacturing executive; graduate of Purdue University.

The Division of Engineering is a free Government employment agency for employers and employes. For full information in regard to the men listed and the service of this Division, apply to the Director as above.

A NATIONAL COMMITTEE of educators is being organized to support the Smith-Howard bill now in congress for the establishment in connection with state-supported universities and colleges or engineering schools of engineering experiment stations for the promotion of engineering and industrial research as a measure of industrial, military and naval preparedness in times of peace and war.

The announcement was made by P. V. Stephens, consulting engineer, with offices in the Metropolitan Tower, New York City. Mr. Stephens is the author of the bill, which has already had one hearing before the committee on education of the House of Representatives. A second hearing on the bill is expected to be called before Nov. 1.

More than 35 educators, representing as many educational institutions, have already become members of the national committee, and other colleges and universities are sending in their acceptances daily, Mr. Stephens said. A meeting of the committee will be held in Washington on Nov. 12, when a chairman will be selected. Among those spoken of for the head of the committee are Dr. Richard MacLauren, president of the Massachusetts Institute of Technology, who is director of education of the War Department's Committee on Education and Special Training, which has jurisdiction over the Students Army Training Corps in the colleges throughout the country, President Jacob G. Schurman of Cornell University, and Dr. W. R. Whitney, who is director of the research laboratory of the General Electric Company and a member of the Naval Consulting Board.

In a recent letter to Secretary of Commerce William C. Redfield, in reference to the Smith-Howard bill, Dr. Whitney wrote:

"There is no subject of greater interest to the industries and to engineers today than the future of engineering education and scientific work behind it. We are lamentably weak in trained men, men interested and well grounded in science. What this country can accomplish is determined, in general, by the limits of the education we give our young men. Where we fail is in the more advanced scientific teaching. We have done comparatively little in this country to support research workers in our universities. It is in this field that Germany became most successful. Almost every small German town became noted for the laboratory of a Liebig, a Bunson, a Wohler, an Ostwald, a Nernst, or a Haber, and scores could be mentioned.

"Recently the Smith-Howard bill came to the front and seems such an improvement over earlier attempts directed to this need. I believe the colleges in the widely separated parts of our country are the best places to discover and develop future American scientists, engineers and inventors. Now that the proposed legislation fixes the supervision in an organized, existing, active bureau, I feel that the experiment is more than ever worth while. I can see no possible personal gain in such plan, and so I hoped I might thus the more easily be of service in helping such a movement."

THE DEFENDER Automatic Regulator Co., of St. Louis, Mo., has recently moved to larger quarters at 709 Pine St., where more room is provided for handling its increasing business in the marketing of efficiency instruments and damper regulators for the boiler room.

THE PATTERSON-KELLEY CO., manufacturer of feed water heaters and hot water heaters, announces the removal of its Philadelphia office to the Harrison Bldg., 15th and Market Sts., where District Sales Manager Frank F. Glenn will be in charge.

THE PRECISION INSTRUMENT CO. has moved to new and larger quarters, with added facilities for manufacturing and marketing its products. The office is at 83 Fort St. West and factory at 102-104 Wayne St., Detroit, Mich.

AT THE Fourth National Exposition of Chemical Industries, recently held at Grand Central Palace, New York City, the exhibits showed how in response to the needs of war times the chemists of the country have freed us from dependence on Germany. Among the products shown were dyestuffs, byproducts of coal, coke iron and cement, enamels, cork, asphalt, lenses, porcelains, potash, heat resistants,—together with the processes and machinery for their production.

The Government had an exhibit of incendiary bombs, and gas shells and bombs, and the Fuel Conservation Board of the products derived from coal, containing more 200 different products, ranging from coal tar to perfumes.

Within 2 yr. industries which seemed threatened with collapse for lack of dyes and coloring matters are operating normally, the materials having been supplied by chemists from our own resources; and in addition, large amounts of these products are being exported. Optical and chemical glass, heretofore chiefly produced in Germany, are now being made here in large quantities. And these industries have been established, not temporarily, but for all time to come, so that the gain from meeting our war-time needs will be permanent.

The next exposition will be held in the Coliseum, Chicago, in September, 1919.

DISTRIBUTION of Skookum packing for New York City and immediate vicinity is now in the hands of the New Jersey Asbestos Co., New York City. Announcement of the appointment of the New Jersey Asbestos Co. was made recently by the manufacturers, the Bowers Rubber Works of San Francisco, through its eastern representative, W. L. Rogers.

CHICAGO PNEUMATIC TOOL CO. announces the election of H. D. Megary to the office of secretary, vice W. B. Seeling, resigned.

Catalog Notes

THE NATIONAL STOKER, made by M. A. Hofft Co., Indianapolis, Ind., is described and illustrated in that company's latest booklet.

ADVANTAGES of the Alberger multi-head heater are discussed in a booklet from Alberger Heater Co., Buffalo, N. Y.

CAST-IRON ash pit doors and the American steam jet conveyor are discussed in a folder from American Steam Conveyor Corporation, 110 W. 40th St., New York.

SNOW four-cycle oil engines are described, together with illustrations and dimension tables, in Bulletin S-160 of Worthington Pump & Machinery Corporation, 115 Broadway, New York.

FOLDERS have been received from Depere Mfg. Co., Chicago, as follows: No. 1—Bringing in Boiler Coal from Car and Yard; No. 2—Easy Handling of Coal from Car to Boilers.

TUXEDO SWING JOINTS for conducting steam, water, oil or gas are the subject of an illustrated circular, with price list, issued by Franklin Williams, Inc., 39 Cortlandt St., New York.

THE STOKER for the Higher Volatile Coals is the title of a pamphlet discussing the Laclede-Christy chain grate stoker, manufactured by Laclede-Christy Clay Products Co., of St. Louis, Mo.

POMONA duplex plunger power pumps are described in Bulletin No. 318, which shows by vertical cross section of power head how the balance of the reciprocating parts is obtained, also illustrating a typical deep well installation. The maker is United Iron Works Co., Springfield, Mo.

THREE of the latest publications of Armstrong Cork Co., Pittsburgh, Pa., have been received, as follows: Maintaining Morale; Nonpareil High Pressure Blocks and Cement; Linotile Floors.

The company will be glad to send copies to all who are interested.

MUELLER RAPIDAC and some late specialties in brass plumbing supplies are illustrated in a catalog from H. Mueller Mfg. Co., of New York.

Another recent catalog deals with that company's regulating, relief and air releasing valves, water strainers and pipe end reamers.

HEATING APPLIANCES made by the General Electric Co. are described and illustrated in a booklet recently issued by that company.

A FOLDER relating to the McDonough Fuel Saving System was lately received from McDonough Automatic Regulator Co., of Detroit, Mich.

PHOTOGRAPHS portraying the durability of National pipe illustrate a recent folder of National Tube Co., Pittsburgh, Pa.

CIRCULAR COIL, oil insulated, self-or water-cooled transformers of medium sizes and moderate voltages are the subject of General Electric Co.'s Bulletin No. 45,203.

AMONG THE NEW TYPES of apparatus listed for the first time in the revised edition of Westinghouse Catalog 3-B are the types AW and FW duplex instruments, which consist of any two of the standard types AW or FW instruments, respectively, contained in attractive dull black metal cases; the types EH and PH ammeters, which are hot-wire instruments suitable for operation on either direct-current or alternating-current circuits of any frequency; the type OA watthour meters for switchboard service, which are similar to the well-known standard house-service type OA watthour meters, except that they are designed for switchboard service; the motor-operated type M graphic instruments; type CV voltage relays, which can be furnished to operate either on under-voltage or over-voltage, as ordered; the type CP reverse-phase relays to provide against phase reversals; type BT transfer relays, which operate with the excess current relays, such as the Westinghouse type CO and type CR to energize directly the operating coil of the circuit-breaker from the current transformer, no separate operating circuit being required; and type CT temperature relays, which depend for their operation upon the temperature of the apparatus on the circuit as well as the amount of the overload.

This catalog, listing instruments and relay in standard 8½ by 11 size, is a departure from the original edition of the same catalog, in that wherever possible each particular type of apparatus is listed on only one page, and where more than one page is required the several pages necessary are confined to a description and listing of only the one particular type.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Power Plant Engineering, published Semi-Monthly at Chicago, Ill., for October 1, 1918.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Arthur L. Rice, who, having been duly sworn according to law, deposes and says that he is the Editor of the Power Plant Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Name of — Post Office Address—
Publisher, Technical Publishing Co., Chicago, Ill.
Editor, Arthur L. Rice, Chicago, Ill.
Managing Editor, None.
Business Manager, E. R. Shaw, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

Technical Publishing Co., Chicago, Ill.
E. R. Shaw, Chicago, Ill.
A. L. Rice, Chicago, Ill.
C. S. Clarke, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.)

Arthur L. Rice, Editor.

Sworn and subscribed before me this 18th day of October, 1918. Warren A. Lathrop, Notary Public.

(SEAL) (My commission expires October 16, 1922.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.